Radio, Electronics and Communications

FORMERLY "RADIO & ELECTRICAL REVIEW" — WIDELY KNOWN SINCE 1946 AS "R. & E."

MPL

In This Issue . . .

- Phasing and Balancing Your Stereo Systems.
- The Ultimate in Transistors.
- R.E. & C. 6" Experimenter's TV. Set.
- Listening Post.
- Medium Power Semiconductor Rectifiers.
- Serviceman's Column.

PUBLISHED MONTHLY IN THE INTERESTS OF THE N.Z. ELECTRONICS INDUSTRY FOR ALL LEVELS, FROM PROFESSIONAL TO AMATEUR.

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MARCH 1, 1965

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AWA

AWA to supply Dunedin two-camera O.B. Vehicle

See page 33

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Vol. 20, No. 1 March 1, 1965

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On Our Cover

A.W.A. TO SUPPLY DUNEDIN TWO-CAMERA O.B. VEHICLE

Our cover this month features the new type of two-camera Outside Broadcast Vehicle which Amalgamated Wireless (Australasia) N.Z. Limited is to supply to Dunedin under a contract awarded by the New Zealand Broadcasting Corporation.

For a full explanation and further illustrations of the supply of this interesting unit please see page 33.

ENQUIRY CARD AD. 4

COMING . . .

Noise Limitter
Design of ⅝" Wavelength Whip
Looking at Column Speakers
Transistorised Oscillator
Technician Training
Mobile Communications Series
INDEX to Volume 19

And . . .

Serviceman's Column
Listening Post
Book Reviews
Circuit & Service Data
New Products

Letters from Readers

Sir,

As a long-time reader of Radio and Electronics I am going to ask if you will help me.

I have a Honeywell Electronic Flash Gun and have tried everywhere in Wellington to find circuits and data on symptons and what to do to remedy faults, this along the lines that I already have for Radio and TV Servicing.

R. ROGERS,
Lower Hutt.

After some delay we have found that PAYKEL BROS. LTD. are the agents for Honeywell and should be able to help you.

As you do not state the year or model we are unable to help you directly on this occasion.

I suggest you write to your local Paykel Bros. office seeking the data you want.

—Ed.

Sir,

Would you please send me a Jan. 65 issue of "Radio, Electronics and Communications". Apparently all newsagents were sold out at the time of intended buying and a thorough search of AK proved fruitless.

I must admit I find your magazine most excellent and enjoy each page. Enclosed Postal Note to cover same.

R. A. FALK,
Avondale.

Thank you for your comments. The magazine has been sent.

—Ed.

Sir,

Would you please forward me a copy of November 1964 "Radio, Electronics and Communications." This number sold out very smartly at my normal bookseller and was also unobtainable from Gordon and Gotch.

With regard to incorrect circuit diagrams, it would be appreciated if a fly leaf could be added to a future magazine. The fly leaf could then be placed with the relative circuit diagram.

A postal note will be forwarded on receipt of invoice.

P. A. WALSH,
Wellington (ZLW).

The copy has been sent to you. We will look into the suggestion of a fly leaf which is a good one; however economic considerations may rule it out. We do at least endeavour to publish any corrections at first possible opportunity.

—Ed.

Sir,

With reference to your subscription invoice for the Radio, Electronics and Communications magazine, I wish to advise that I have been transferred temporarily to Fiji.

As I have neither paid the subscription concerned nor received any magazines from you I would like to know whether it would be possible to send the magazine to me here.

If this is possible, I can arrange to have the subscription paid by my Bank in Auckland.

Could you please let me know as soon as possible.

80054 LAC BEETS I.R.
Laucala Bay.

We are quite happy to arrange supply for you as we already do for a number of overseas subscribers.

—Ed.

SEMICONDUCTOR RECTIFIER DIODES

Guidance on the minimum data to be quoted by a manufacturer of semiconductor devices in describing his products for general sale is given in a British Standard, B.S. 3771 Recommendations on semiconductor rectifier diodes (monocrystalline) which is divided into three sections covering essential ratings and characteristics, methods of measurement of electrical characteristics and assessment of working conditions.

Data quoted serves two main purposes: it eases comparison of semiconductors of the same general class, offered by different manufacturers; and it defines the ratings and characteristics sufficiently to enable users to determine the suitability of particular types for circuit design purposes.

The Axe Grinders

In the fashion and social worlds there are times of the year known as ''silly seasons''. Not much happens, so to enliven things a few ridiculous ideas are given an airing.

The 1965/1966 Import Licensing Schedule has just been announced and whilst waiting for this the radio and television industry has been having a ''silly season'' of its own.

Whilst it is very unlikely to happen, from time to time suggestions are made that Import Control should be dropped. Even more frequently is the clamour made for increased licences for material for the ''entertainment'' side of the radio and television industry.

Presuming that the demand will keep up — which we very much doubt — these two attitudes can be viable. But when requests for both decontrol and strict control come from the same industry associations it is obvious that decontrol is wanted so that more turnover can be built up but at the same time should be strictly controlled so that no one else (overseas) can have a bite of the cake.

A similar ''I-want-to-be-alright-Jack'' attitude is apparent concerning the importation of passenger's ''personal imports'' such as transistor radios, small TV. sets and cameras. Local manufacturers and suppliers want the Government to reduce the permissible value that can be brought in after a trip overseas — it is affecting business, they say. Surely the relatively few items so imported should be a spur to local industry to raise its manufacturing standards even if the prices cannot be met entirely.

Studying the press statements from the industry over the past eighteen months or so it seems as if no coherent (one could almost say ''adult'') attitude has been aimed at and the inescapable conclusion we draw is that no local association has yet formulated a firm technical plan for the industry. There is a lot of pressuring for a second TV. channel with little regard for the many country areas with no TV. at all at present.

Filling the gaps is perhaps not as lucrative as set demand once a second channel is available. There has even been some quiet flogging of the yet unborn colour TV. horse, but this was quickly dropped when set sales tended to drop for a month or so.

What is needed is an association within the industry concerned with ethical and technical matters and not with Dealer's Associations. Perhaps this will not come about until sales are falling away and profits dropping and the non-technical get-rich-quickers look for some other avenue of investment.

After all it's all old history. The domestic appliance industry in this country was in this state 30 years ago and it is only in the last decade that it has become stable and efficiently managed — and capable of meeting competition.

Phasing and Balancing Your Stereo System

by Irving Spackman, A.M.I.E.E.E.

Judging by the number of letters we have received on the subject, there are a percentage of our readers who desire some method or simple instrument to ensure that their stereo phasing and balancing adjustments are correct. The probable reason for this is that Phase distortion is probably the most difficult aural distortion to detect by casual listening methods. The human ear is less sensitive to phase distortion than to frequency or harmonic distortion especially where only a single sound source is involved. Nevertheless, in this era of stereophonic and low distortion reproduction, phase distortion should be reduced or eliminated if possible from our equipment if the best possible sound reproduction is to be obtained.

This article will try to survey some of the methods which can be used to detect for incorrect phasing and balancing of stereo systems.

WHAT IS PHASE?

First, let us define what is meant by "phase" in a multi-channel system. All audio waveforms no matter how complex, can be reduced to a series of sine waves differing in amplitude, frequency and phase. Phase in this context refers to the position of each sine-wave component in time relative to all the other sine-wave components. It has been demonstrated by the Bell Telephone Laboratories that the ear is insensitive to the phase of these sine waves. This conclusion applies only to a single waveform issuing from a single sound source. We might call this "internal" or "self" phase. Thus it is necessary to consider only external phase problems and characteristics.

External phase is the time relationship between two waveforms of the same waveshape emanating from two or more separate sound sources. The ear is exceptionally sensitive to external phase shifts. Indeed, the existence of stereo perception is, to a large extent, dependent on the ear's ability to detect even small external phase differences.

Stereo perception depends on a combination of amplitude and time differences between the two channels usually found in domestic equipment. It is the recording technician who must capture these amplitude and time differences on tape or disc, and it is the function of the reproducing system to reproduce these differences with as much fidelity as possible, if the original stereo concept or image is to be accurately re-created in the home.

The simplest form of phase distortion is a complete change in the polarity of one channel with respect to the other. The aural results of such distortion are loss of bass response, lack of centre-channel presence, and a generally confused sound pattern. The loss of bass response occurs because of acoustic cancellation of completely out-of-phase signals in the listening room. The amplitude of the lower bass frequencies is affected more than that of the higher frequencies because the microphone spacing used to make most stereo recordings is small compared to the wavelengths of the lowest bass frequencies, so that the low bass always arrives at both microphones essentially in-phase. Thus if the two signals are combined out-of-phase, electronically or acoustically, bass cancellation will occur.

It can be demonstrated that identical in-phase signals applied to two loudspeakers will produce a virtual image midway between them for a listener who is sitting between the two speakers. The reproduction of solo or centre orchestral instruments from two side loudspeakers is only possible because of this effect. If the phase of one speaker is reversed, the centre image is destroyed and the side speakers are heard individually.

The inexperienced stereo listener can carry out a simple experiment to observe these phase effects. All that is necessary is a set of stereo headphones. Headphones have the virtue of eliminating the effects of room acoustics and magnifying out-of-phase effects to the point where they become very easily detectable by even the most inexperienced listener.

The headphones should be fed from a single monaural system, and some means must be provided to reverse the leads to one earphone. Any type of programme material is suitable. A few minutes of listening whilst reversing the leads to one earphone will demonstrate the basic character of out-of-phase reproduction. It is interesting to note in this case that bass cancellation does not occur with out-of-phase signals when headphones are used. This proves that the bass cancellation occurs acoustically in the listening room, and not in the brain. The brain does not interpret phase differences in terms of volume level but in terms of direction and distance.

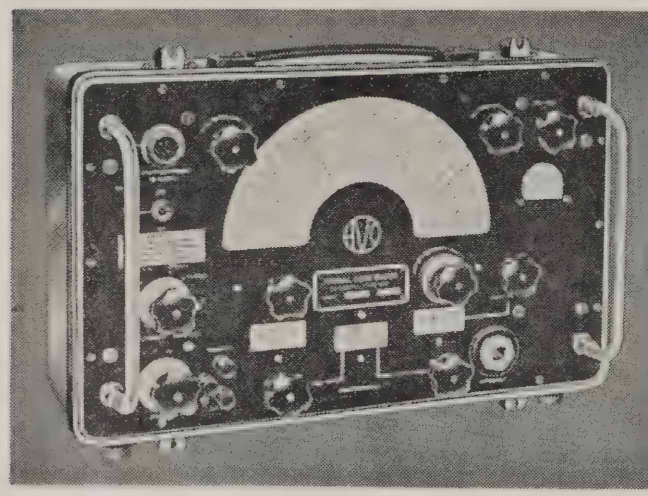
SYSTEM PHASING

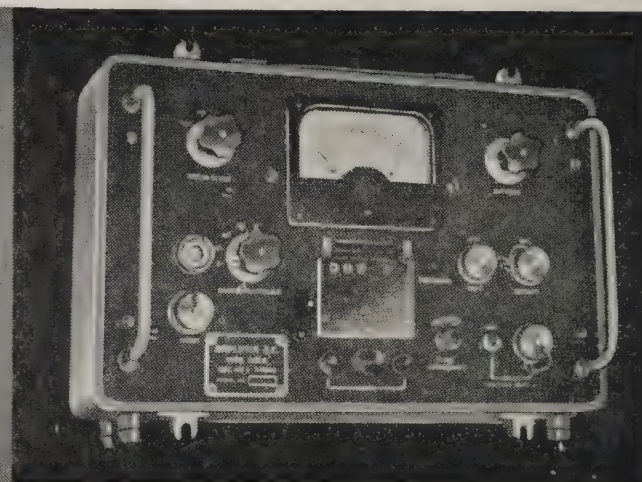
Now that we can recognise the nature of phase distortion, let us consider some practical methods of correctly phasing our stereo system. We can do this in two ways, these being aurally, or with instruments. First we will discuss aural phasing methods and then describe a simple instrument to serve the same purpose.

For aural phasing, we must firstly arrange our loudspeakers so that they will produce a strong in-phase sound pattern. This means, of course, that the tweeters must be in phase with the woofers. If this is not so, then acoustic cancellation can occur near the crossover frequencies, and phasing

ENQUIRY CARD AD. 9

Electrical measuring and testing Precision Instruments





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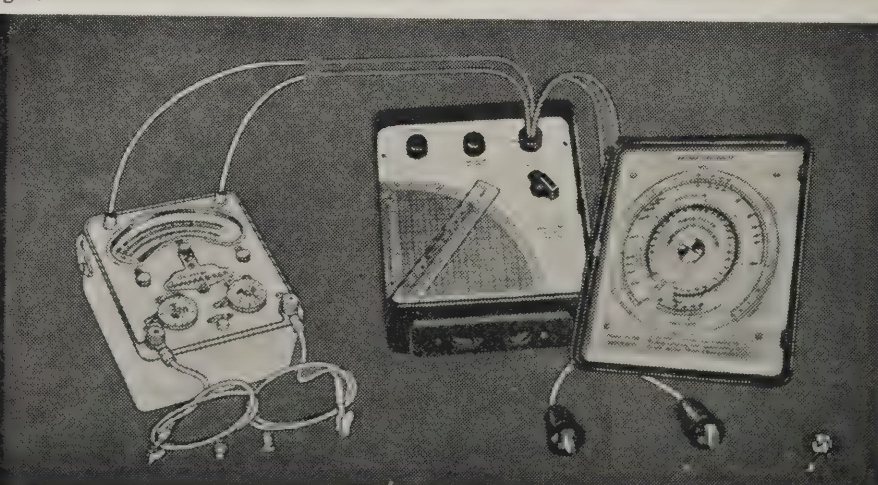
An inexpensive general purpose a.m. signal generator of entirely new design for the service engineer.
The new design of attenuator, coupled with adequate double r.f. screening, results in a remarkably close adherence of the output to the attenuator calibration, combined with a very low leakage figure.

AVO portable d.c. amplifier

A highly stable d.c. amplifier which has been primarily designed to measure the minute currents produced in ionization chambers, but it has applications in medicine, industry and experimental work in connection with reactor instrumentation.



AVO signal generator, Type 378

This instrument will provide r.f. signals between 1uV and 250mV into a 75 ohm load at any frequency between 2/Mc/s and 225/Mc/s, this being accomplished in 7 ranges.

Universal Avometer power factor and wattage unit

This unit which works in conjunction with the Model 7 AvoMeter or the Model 40 AvoMeter (2 models available) brings power factor and wattage measurements within the scope of every engineer without a great capital outlay.
The accuracy is far higher than is usually required for commercial purposes.
There is also a full range of AVO Test and Measuring Instruments.

A3.4

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one such speaker combination with another can be a difficult job. If the terminals of the woofer and tweeter are accessible, then phasing is best accomplished by connecting a flashlight battery across each speaker in turn and observing the direction of motion of each cone. Connect together the leads from each speaker that were placed, on for instance, the positive terminal, to produce outward cone movement and then with the other two wires joined together connect to the amplifier. If a cross-over network is utilised then maintain the correct phasing when inserting this.

Having established the phase of each speaker combination, it is now necessary to phase the whole stereo system. To do this, connect each speaker to its own amplifier, set the balance control at centre, and feed a monophonic programme into the two amplifier inputs in parallel (the amplifier may have a "mono" switch position, and if so, this can be used with one programme source fed to either amplifier). The phasing of one amplifier is altered if necessary to produce a distinct sound source coming from between the two speakers. If the signal appears from either speaker or there is a "hole in the middle" effect, particularly on bass passages, then change the phase of one speaker. This bass cancellation effect is particularly obvious if the speakers are placed side by side.

One of the best methods for establishing the correct phase is to use a white noise source and feed this to both speakers through one amplifier, to check just the speakers, or alternatively, and better still, through both amplifiers connected to their correct speakers to check the complete system excluding the pickup. The noise should emanate from both speakers at equal volume, and should appear to come from between the speakers, not from either one or the other.

Reading through the correspondence which has come in on the subject, we have discovered that some of the writers are using dissimilar amplifiers, or speaker systems or both, in their stereo equipment. In this case, if the amplifiers are different, then volume controls, tone controls, and speaker connections would need adjustment. If a dual type amplifier is used with dissimilar speaker systems, then the balance control, speaker tappings on the output transformers, together with phasing adjustments; and the position of each speaker with respect to the listener and the room may have to be altered to produce the noise source emanating from a point mid-way between the two speakers.

Sometimes if very dissimilar multispeaker systems are used, particularly ones with several speakers or complicated cross-over networks, or radically different cabinet construction, then phase reversal makes little difference in the quality of the "white noise". In this case, the phase, frequency, and amplitude relationships, in each speaker are so different, that they cannot be maintained in-phase with each other in more than one part of the audio frequency range at once. These speakers are not suitable for use in a stereo system.

To obviate the problems associated with the aural method, a simple instrument can be constructed, which will give a true picture of both amplitude and phase balance in the stereo system. The circuit of this instrument can be seen in Fig. 1. Two identical transformers, each with 2 separate windings are used and connected across the output from the two amplifiers in parallel with the speakers. A double pole double throw toggle switch changes the circuit for either phase or amplitude measurements. In the amplitude position (see Fig. IA) the voltage appearing across each output line is rectified by a diode rectifier, connected across a load resistor to produce a positive voltage out. The voltage appearing across the two resistors in series is measured by a D.C. voltmeter, consisting of a micro-ammeter with "centre-scale" adjusted pointer. With no signal present, or, if the two signals have identical content and amplitude, as should occur if a monaural programme is played through both channels, then the meter will not be deflected. If the left channel has a signal, and the right none, then the meter will be deflected backwards, if the right channel has the signal and the left none, then the meter will be deflected forwards. (This of course, depends on the correct

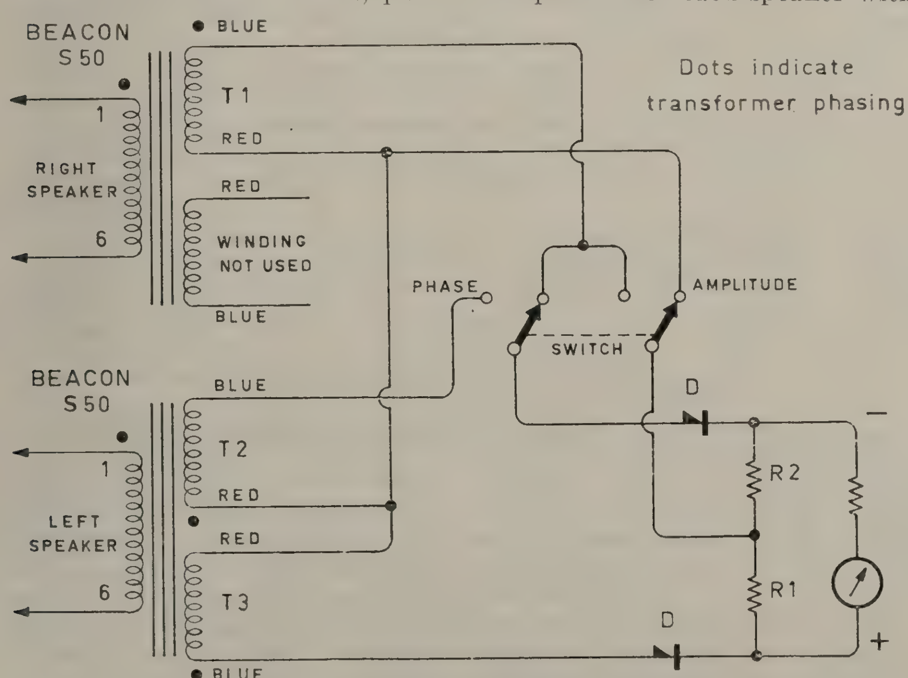

FIG.1 STEREO ANALYSER.

DIODES 'D' — OA 85
(SEE TEXT.)

polarity connection of the meter). When both right and left signals are present, the meter is deflected in either direction by the voltage which is equal to the difference between the two source voltages.

With monaural programme material it is easy to establish the exact balance, as the levels should correspond exactly, provided there are no frequency response differences or amplitude non-linearity conditions in either system. With a stereo programme source, the levels will not correspond, so the meter will vary from positive to negative. In most cases however, there is considerable programme which is common to both channels, and by watching the meter needle excursions from positive to negative, one can rapidly balance the two channels.

In the phase position of the switch (Fig. 1B), one rectifier develops across load resistor R2, a positive D.C. voltage proportional to the two channels summed, and the other develops a positive D.C. voltage across load resistor R1 that is proportional to the difference. Then, with in-phase signals applied to the left and right channels, the voltage across R1, is zero, because the windings of T1 and T3 produce equal and opposite voltages that cancel. The voltage across R2 is positive and double what would be produced by one winding, because T1 and T2 are additively phased. The meter is connected to take the difference as before and reads negatively. By the same reasoning, the voltmeter reading with out-of-phase signals is positive.

The phase reading does not depend on the amplitudes of the two channel signals. As the level on either channel decreases, the deflection drops, but is always of the same polarity. If one channel is not operating the output reading is zero.

One interesting point arises when using this test equipment. Surface noise on stereo recordings is generally out of phase with programme material. This is because most of the surface noise is in the vertical component of the needle movement. This illustrates that when a stereo cartridge is

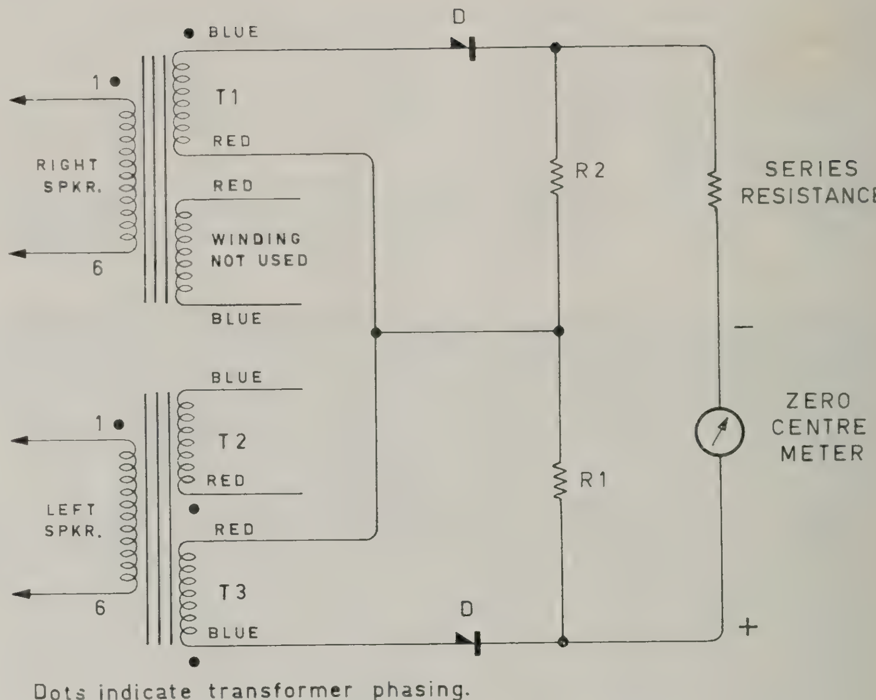

FIG 1A SIMPLIFIED DIAGRAM OF AMPLITUDE SENSING CIRCUIT.

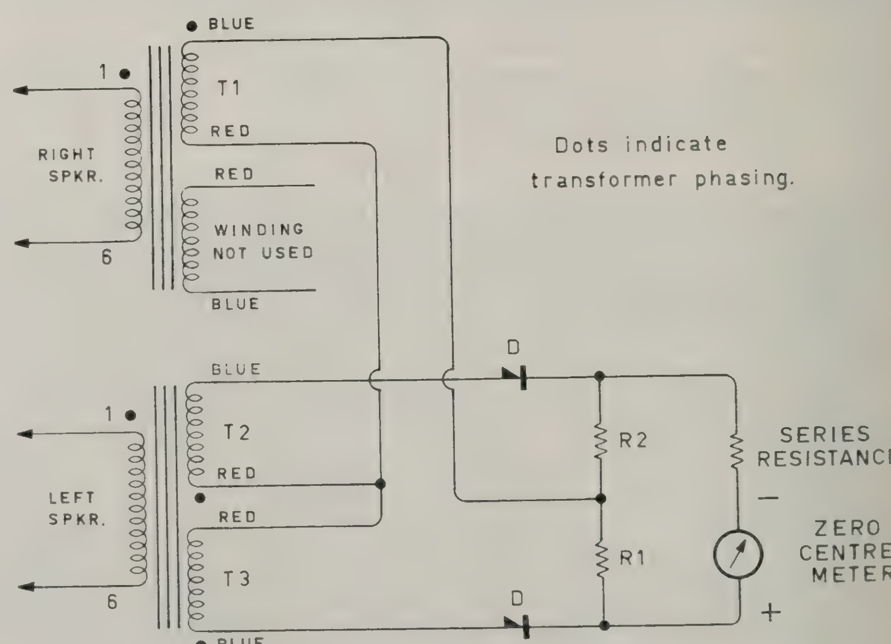

FIG.1B SIMPLIFIED DIAGRAM OF PHASE SENSING CIRCUIT.

used to play "mono" records, with both chanels connected together, there is a reduction in surface noise due to phase cancellation.

In the circuit shown, the diode rectifiers are the limiting factor on the voltage which should be applied across the primaries of the transformers.

Do not increase programme level beyond 1 watt output if a 15 ohm speaker line is being used otherwise the voltage across the diode could be excessive. If more power level than this is desired, then the OA85 diodes should be replaced with a silicon diode of 200 volts P.I.V. or more. How-

—Continued on page 37

Medium Power Semiconductor Rectifiers

Part III—Concluding Article

Last month single phase rectifier circuits were examined from a theoretical viewpoint and it was shown that the full wave bridge circuit was the most efficient from transformer utilisation and rectifier reverse rating aspects. In this concluding part the practical aspects of circuit parameters are discussed and the case of a low voltage general purpose power supply is studied.

As indicated in the introduction to last month's section of the subject the results given for all cases were based on there being no losses in the circuit elements and the loads being purely resistive with no filtering. The modifying effects of the load and filtering are most important and in only the simplest cases can filtering be omitted.

Filtering, to be of any value, must comprise of worthwhile values of either capacity or inductance or, what is more usual, combinations of both. The filtering elements allied with a possible reactive load can cause appreciable departure from the current and voltage waveforms upon which theoretical values have been placed.

For instance, a capacitive load or filter can result in the current through the rectifier being pulsed rather than sinusoidal; this is due to the build-up of voltage in the capacitor with the result that the rectifier conducts only when the supply voltage exceeds that stored in the capacitor and in the extreme this will only be for short portions of each cycle. Again capacitive loads will present a short circuit to the rectifier when first switched (i.e. in a discharged state) and very large current inrushes can be met, with the only limit being circuit resistance. In many cases the peak current rating of the rectifier will be exceeded and failure to limit this "switch on" current may destroy the rectifier cell.

The case of purely capacitive loads as against capacitive filtering, is a special one not met very often. Whilst this Centre's Laboratory designed such a rectifier set it is felt that the case of a more usual load would be better discussed now.

To illustrate the effect of two methods of filtering on component values the same load will be dealt with in two examples — capacitive filtering and inductive filtering.

A Practical Case

With the rapid rise in the use of transistor equipment power supplies offering 50V output at up to 2 amps are often required. A universal power supply for transistor work is not an easy item to design and, in practice, is usually solved with a regulated variable output supply. However, where an unregulated output is no serious disadvantage a standard full wave bridge supply can be useful.

Design Requirements

output voltage	50V D.C.
output current	2A D.C.
maximum ripple voltage	.25V R.M.S.

A low ripple content is needed if the power supply is to feed amplifier circuits and this factor is undoubtedly **the most important** in all power supply design for electronic equipment.

Its importance is evident from a study of published design material. Almost without exception the methods used are based upon an initial requirement of ripple content. The method used below is based upon the work, of Schade (1) and it is his method that is used in most references. Figures 4 to 8 are based on those from a recent Mullard publication; (2) that reproduces Schades graph in a large workable form.

Whilst practical design takes into account the effect of circuit resistances and impedances the initial calculations require an assumption of the total value of the series resistance in the rectifier circuit, Rs in figures 1 and 2. The ultimate aim is to produce a required AC voltage output from the secondary of the rectifier transformer and until this is known the **exact** value of the series resistance cannot be known. In detail it may be necessary to run through the calculations two or three times modifying certain parameters.

An example of this is the effect of the short circuit current (into a discharged filter capacitor). Should this value be too high for the selected rectifier either the rectifier will require to be reselected or more usually, some series limiting resistance added.

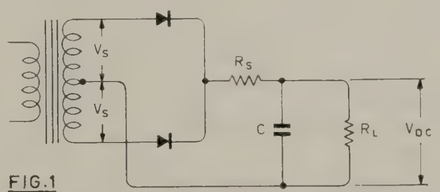

FIG. 1

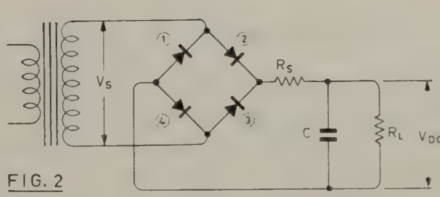

FIG. 2

In practice the series resistance, Rs, can be assumed to be not more than 5% of the load resistance, RL.

In our case:

$$R_L = \frac{50}{2} = 25 \text{ ohms}$$

$$R_s = 1.5 \text{ ohms, say}$$

$$\% \text{ ripple} = \frac{.25}{50} = .5\%$$

$$\frac{R_s}{R_L} \% = 6\%$$

CASE 1

For capacitive filtering, figure 2

Using figures 4 to 8 which are applicable to either full wave bridge or centre tapped circuits we first determine the value of $\omega R_L C$ from figure 5

$$\omega R_L C = 120 \text{ approx.}$$

$$R_L C = \frac{120}{2\pi\ 50} = \frac{120}{314}$$

$$C = \frac{120}{314 \times 25} \text{ Farads}$$

$$= 15{,}000\ \mu F$$

(It may be necessary to find a value of capacity that falls in with what is obtainable from suppliers and recalculate for that value of C.)

It is generally accepted that a power supply having a capacity in the output of 2000–5000 μF presents sufficiently low loop impedance for most transistor power amplifiers. In the case under consideration this value is considerably exceeded.

Knowing the value of $\omega R_L C$ figure 4 can be used to determine the ratio

$$\frac{V_{DC}}{V_s}$$

thus

$$\omega R_L C = 120 \text{ and } R_s/R_L = 6\%$$

$$\frac{V_{DC}}{V_s} = 82\% \text{ approx.}$$

from which Vs can be found:—

$$V_s = \frac{V_{DC} \times 100}{82} = \frac{50 \times 100}{82}$$

$$V_s = 60$$

$$V_{RMS} = \frac{60}{\sqrt{2}}$$

$$= 43 \text{ volts}$$

In the case of a full wave bridge Vs is the CWV (PIV) that each rectifier has to withstand **BUT** in the case of the centre tap connection the CWV would be 120 volts.

Next, the RMS current per rectifier arm (1, 2, 3 or 4 in figure 2) can be found from figure 6 for $\omega R_L C = 120$ and $R_s/R_L = 6\%$

$$\text{thus} \quad \frac{I_{RMS}}{I_{AV}} = 2.4$$

and for Fullwave bridge circuits the average current per rectifier is the DC load current divided by 2 i.e. 2 paths (arms 1 and 3 or 2 and 4 in figure 2).

$$\therefore \text{Av. current} = \frac{2}{2} = 1A$$

$$\therefore I_{RMS} = \frac{2.4}{1}$$
$$= 2.4A$$

It is now possible to make an initial selection of a rectifier knowing the peak voltage and RMS current.

From figure 7 the peak current can be found for the Rs/RL % and $\omega R_L C$ that are known.

It will be see that

$$\frac{I_{PK}}{I_{AV}} = 7 \text{ approx.}$$

$$\therefore I_{PK} = 7 \text{ Amps}$$

The switch on current rush

$$I \text{ inrush} = \frac{V_s}{R_s} = \frac{60}{1.5} = 40A$$

This may occur for several cycles and it is essential that the rectifier can withstand this and the repetitive peak current above. Reference to the manufacturer's curves or published data is needed to ensure this. The series resistance may need to be increased and the whole series of calculation done again.

Capacitor ripple current

The RMS ripple current can be found from the formula

$$I \text{ ripple RMS} = \sqrt{2\ I_{RMS}^2 - I^2_{DC}}$$
$$= \sqrt{2 \times 2.4^2 - 2^2}$$
$$= \sqrt{11.6 - 4}$$
$$= \sqrt{7.6}$$
$$= 2.75 \text{ A}$$

Reference to the capacitor manufacturer's rating sheets will be necessary to make sure the capacitor will withstand this ripple current.

The final steps are determined by the rectifier finally chosen — the need for a transient damping circuit and the design of a suitable heat sink.

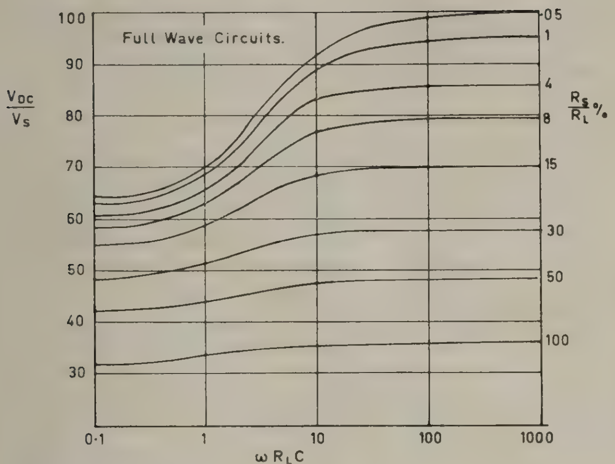

FIG. 4 ω=2πf, R is in ohms, C is in farads.

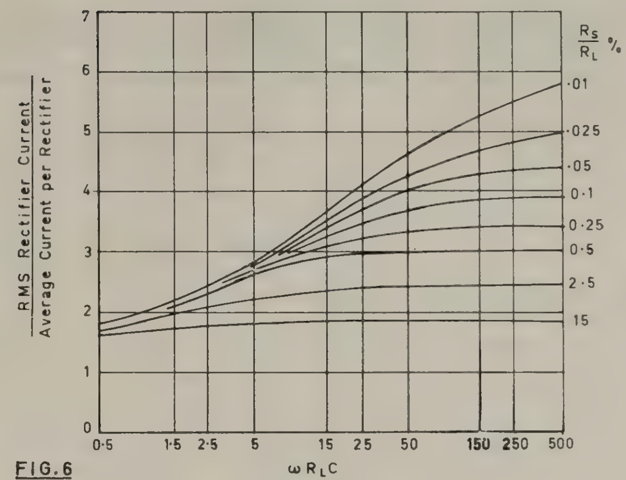

FIG. 6 ω RL C

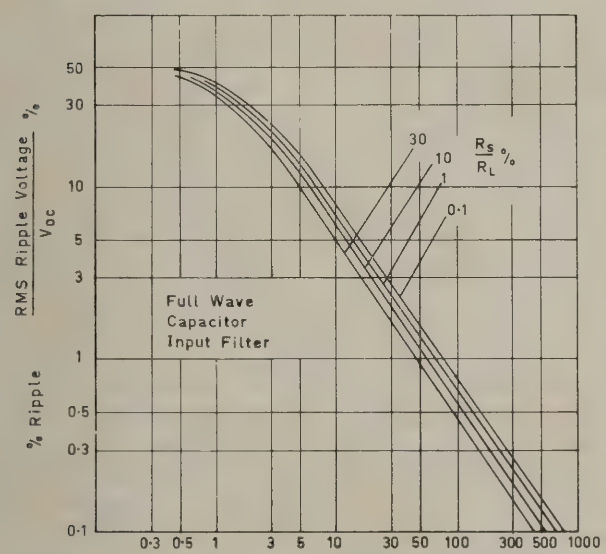

FIG. 5 ω RL C

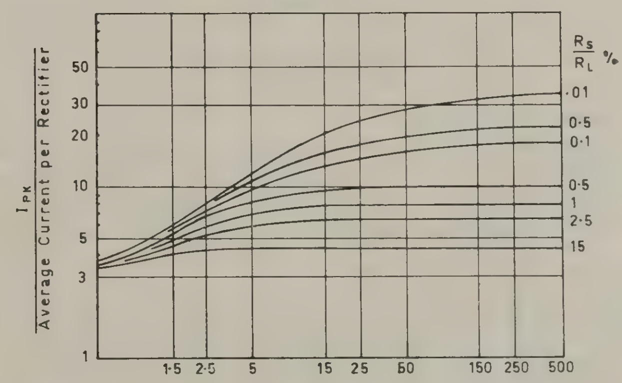

FIG. 7 ω RL C

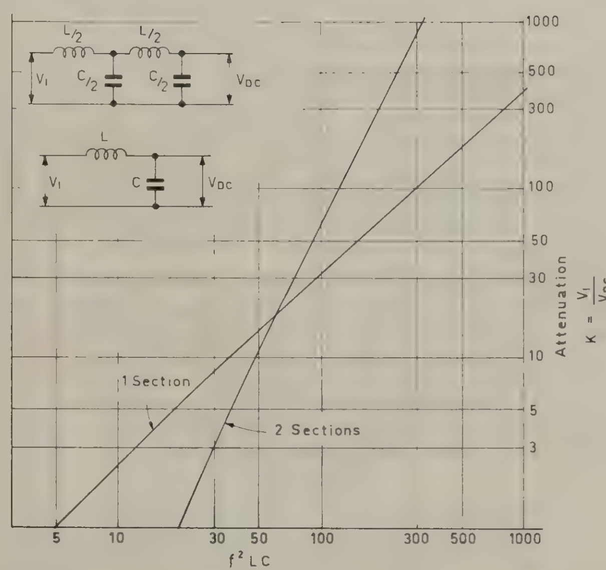

FIG. 8 L is in henries, C is in μF

CASE 2

For inductive filtering, figure 3

The same design requirements apply

$R_L = 25$ ohms, $V_{DC} = 50V$, $I_{DC} = 2A$,

ripple voltage $= .25\ V_{RMS} = .5\%$

The large values of capacity required in Case 1, together with the large values of peak and ripple currents, make capacitive filtering not very attractive when low ripple is required. Another factor not mentioned, but known to most, is the poor regulation obtained from capacitive filtering.

The peaky waveform due to capacitive filtering elements can be reduced, if not completely eliminated, by the replacing of Rs in figures 1 and 2 by a series inductor L. This choke tends to maintain the current and so reduce the rectifier current peaks. The disadvantage is that a higher input voltage is required but this is compensated for by better regulation.

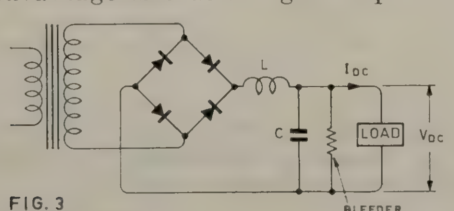

FIG. 3

The usual choke filter network consists of a series L and a parallel C as shown in figure 3 — the inductance presents an impedance to all but direct currents whilst the capacitor shunts the harmonic currents.

The method used to determine the efficiency of inductive filtering depends upon the attenuation of the ripple through the LC section(s). For top efficiency the choke reactance at the ripple frequency

(100c/s for full wave circuits) should be much greater than its DC resistance and the shunt capacitor reactance very much lower than the load resistance

thus $2\pi frL$ is much greater than R_L

and $\dfrac{1}{2\pi frC}$ is much less than R_L

where fr = the ripple frequency

The attenuation factor K

$$= \frac{2\pi frL - \dfrac{1}{2\pi frC}}{\dfrac{1}{2\pi frC}}$$

$$= (2\pi fr)^2\ LC - 1$$

Critical Inductance

A purpose of the inductance is to ensure that the rectifier conducts over each cycle. Failure to sensibly approach this produces the peaky waveform of capacitive filtering and negates the advantages looked for.

It can be shown that for the rectifier to conduct throughout the ripple cycle the ripple current should never exceed the **minimum** load current (DC).

For 50c/s supply (100c/s ripple) and fullwave rectification

$$L \text{ critical} = \frac{R_L \text{ max value}}{943}\ H$$

In some applications the range of load currents will be as much as 100 : 1 so that the inductor, which is passing DC will not have a constant value of L. To overcome this deficiency the inductance can be maintained at a minimum value by always passing at least a fixed current drawn by a shunt bleed resistor.

A more satisfactory method is the use of a swinging choke (in which the inductance is high at low DC currents and falls with increasing current).

To ensure that the inductance does not become too low at maximum currents (i.e. R_L min.) and cause capacitive type current peaks the full load inductance (Lf) should be at least

$$\frac{2R_L \text{ min.}}{943}\ H$$

It can be shown that the RMS ripple current

$$I \text{ ripple RMS} = \frac{\sqrt{2}}{3}\ V_{DC}\ \frac{1}{2\pi frL}$$

Now the ripple prior to the LC filter section is attenuated K times and for a fullwave bridge circuit the "raw" ripple is 47%

$$K \text{ approx. equals } (2\pi fr)^2\ LC$$

$$\therefore \text{ output ripple } \% = \frac{47}{(2\pi fr)^2\ LC}$$

$$= \frac{1.2}{fr^2\ LC}$$

as fr = 100c/s

$$\% \text{ ripple} = \frac{120}{LC}$$

L in henries, C in μF

Shunt Capacitance

Above it was stated that the shunt capacitance should have a low value of reactance so as to be an effective bypass of the ripple harmonics and the Mullard report (2) states that the reactance should be less than 1/5th of the minimum load resistance

$$C \text{ should be great than } \frac{8000}{R_L \text{ min}}$$

(for 100c/s ripple)

Actual Design

Consider that the load varies from 25 ohm (2A) to 250 ohm (.2A).

$$L \text{ critical} = \frac{R_L \text{ max}}{943}\ H$$

$$= \frac{250}{943}$$

say = 250 mH

and as the desired value is 2 L crit

L = 500 mH = .5 H

$$C \text{ should be greater than } \frac{8000}{R_L \text{ min}}$$

$$\frac{8000}{25} = 400\ \mu F$$

This is too low a value to satisfy the low loop impedance requirements and 2000 μF at least would be needed, thus C becomes the required several times greater than 400 μF.

$$\text{The percentage ripple} = \frac{120}{LC}$$

$$\text{For the values above} = \frac{120}{\frac{1}{2} \times 400\ ^*}$$

(* min value of C)

$$= \frac{120}{200}$$

$$= 6\%$$

whereas .5% is required

Thus the capacity should be at least 4000 μF — 5000 μF is a reasonable value.

—continued on page 27

A device to outpace transistors—when it's made

THE TRANSISTOR IN ITS PRESENT FORM HAS REACHED THE LIMIT OF ITS CAPABILITIES

By GEORGE SHORT

These words appeared in 1963 in a special international issue of Proc. IEEE (the senior periodical on electrical engineering and electronics published in the United States) when Dr G. T. Wright of the University of Birmingham, England prefaced his ideas for a device which promises to out-perform the transistor, especially at high frequencies.

It has not been made—yet.

But Dr Wright (who is a modest man, not given to making reckless claims) bases his opinion firmly on years of work, both theoretical and practical, on devices which have prepared the way for a leap forward in electronics.

What are these new devices? In a nutshell, they are solid radio valves. Instead of a vacuum on which an ordinary radio valve depends to carry out its function, there is a piece of insulating material.

In an ordinary radio valve, electrons "fired off" by the heated cathode travel through the vacuum inside the glass envelope to the anode. We are so familiar with the idea that we no longer pause to reflect that the process is quite remarkable, since a vacuum with nothing in it to carry a current would seem to be the perfect insulator. Yet currents flow freely through the empty space of the vacuum in billions of radio valves every day. Why?

The short answer is that there is nothing—and obviously cannot be in a vacuum—to stop them. Once an electron is released into a vacuum there is nothing to block its passage. The art of making radio valves depends on our being able to perform the trick of firing electrons into a vacuum from a heated cathode. This trick is possible only if the cathode is made of the right materials.

Looking at the radio valve in this way leads naturally to a question. If electrons can be launched into a vacuum, which is an insulator, can they also be launched into conventional types of insulating material? The answer is yes, provided that you choose the insulating material carefully, and use the correct material for the cathode. Dr Wright described how to do it in a communication to Nature in 1958.

It is much more difficult to pass electrons through a solid insulator than through a vacuum, because, even if you succeed in launching them from a cathode they may be stopped on the way. They no longer have a carefree passage through empty space. If the insulator were a perfect crystal, however, the electrons could, in theory, slip through the crystal lattice unimpeded. Unfortunately, there is no such thing as a perfect crystal. The innumerable imperfections in real crystals act as barriers—called "traps"—to the electrons.

To make an insulator carry a current one must therefore solve two problems. The first is the same as in the radio valve: to make a suitable cathode to launch the electrons into the insulator. The second is to remove the "traps" and so allow the electron stream to flow freely through the insulator. When Dr Wright began his research he had no expensive crystal-growing equipment at his disposal. So he took advantage of the peculiarities of cadmium sulphide.

When placed in a tubular furnace heated at one end this material vapourises, subsequently condensing on the cooler parts of the furnace tube. But it condenses in the form of thin plates of crystalline material; not perfect crystals, but quite good ones. Using one of these natural slices of insulating crystal as a base, Wright formed a cathode on it by allowing a blob of indium into the cadmium sulphide on one side of a slice. The anode was a silver contact on the other side of the slice.

These devices—dielectric diodes—worked, except that the "traps" caused by imperfections in the crystal structure prevented current flowing unless a high voltage was applied. Fortunately, it proved to be quite easy to compensate for the crystal defects by heating the cadmium sulphide in an inert atmosphere.

Unlike its radio-valve counterpart, the dielectric diode requires no heater to make the cathode emit electrons. This, of course, is one of the advantages of semiconductor diodes, and transistors. A complete transistor receiver can be run off the amount of power needed to heat up the cathode of one radio valve.

This fact alone made the development of a dielectric triode—the counter-part of a triode radio valve—an attractive proposition. An additional attraction was that the dielectric triode, like the vacuum triode, has a very high input resistance. (The transistor has a low input resistance, and this is a severe handicap in some applications.)

The dielectric triode structure which corresponds to the vacuum triode is shown in Figure 1. Electrons would leave the cathode (known as the source) and travel to the anode (known as the drain). On the way they would pass through the "gate", a

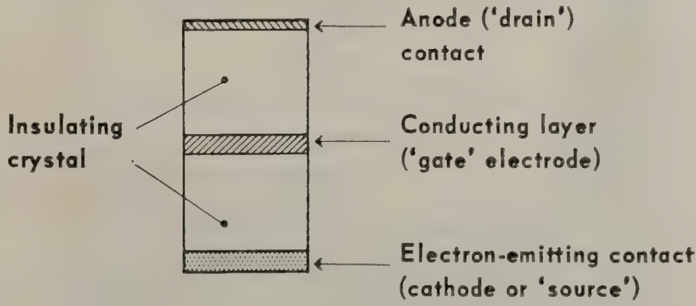

Fig. 1. Diagrammatic cross-section of proposed 'space-charge limited heterojunction dielectric triode'

thin conducting layer which corresponds to the control grid of a radio valve.

This kind of dielectric-triode has not yet been made, because the necessary fabrication techniques have not yet been worked out. Calculations show that it should be vastly superior to both radio valves and transistors. In particular, it seems likely that it could be used as an amplifier at extremely high frequencies, well into the microwave band used in radar. Transistors cannot be made to work at these frequencies nor can conventional radio valves.

In the meantime, another kind of dielectric triode has been developed practically in the United States, and its theory has been worked out by Dr Wright and his colleagues. This is a more modest affair, called the surface-channel dielectric triode. Figure 2 shows the structure.

An insulating layer is covered by a special layer of thin crystalline material. This is the surface channel. Current flowing through the channel from source to drain is controlled by the voltage applied to the gate—a conducting layer on the back of the insulator. These triodes have a rather mediocre performance, compared with modern vacuum triodes, but they are still of great practical interest.

The reason is that they should be very easy to make: it is possible to make them by evaporating material on to the insulating layer—a well-known technique in electronics. It is a technique used in making micro-circuits—complete electronic circuits fabricated from solid material without conventional

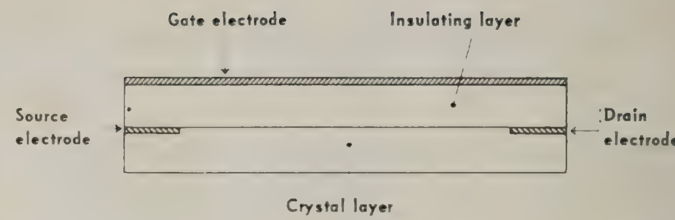

Fig. 2. Cross-section of surface-channel dielectric triode.

components and wiring. Micro-circuits are of interest to computer engineers, because they can be very small and should prove to be most reliable. The micro-circuits of the future may well incorporate dielectric-triodes instead of transistors.

These dielectric valves have some properties which are not shared by vacuum valves or transistors. The University of Birmingham team recently demonstrated how these special properties can be put to use.

First, the dielectric diode. This is what radio engineers call a "square-law rectifier". The current which it passes is proportional to the square of the applied voltage.

Such a diode is free from "wave-form errors", that is, it responds to the true mean value of an alternating current, irrespective of how the current varies with time. This property makes it useful for a number of measurement and control applica-

—continued on page 35

ENQUIRY CARD AD. 12

SILICON DIODE POWER TRANSFORMERS AVAILABLE FROM BEACON RADIO LTD.

R98 T.V. POWER TRANSFORMER

For R.T.V. & H. 1959 and later T.V. Sets. Delivers 260v @ 300mA D.C. Full wave voltage doubler.
230:115v A.C. @ 300mA D.C.
:12.6v C.T. @ 5A (2 windings ea. 6.3 @ 5A).
:0—6.3—7.5—9 @ .6A. Picture tube winding.
Choke:—C36. Use 400v P.I.V. Diodes.

R103 Stereo Power Transformer

R.T.V. & H. Aug. 60. 7w Stereo.
230:245v @ 150mA. D.C.
:104v @ 150mA D.C. Voltage doubler Rect.
:6.3v C.T. @ 5A.
Choke:—C42. Use 400v P.I.V. Diodes.

R104 Stereo Power Transformer. 10w

320v @ 320mA. Voltage doubler Rect.
230:130v @ 320mA.
:6.3v @ 6A.
Choke:—C49. Use 500v P.I.V. Diodes.

R105 T.V. Power Transformer For Philips T.V. Kitsets

220v @ 420mA D.C. Voltage Doubler Rect.
230:106v @ 420mA D.C.
:6.3v @ 10A.
:0—6.3—7.5—9 Ov @ 0.3A. Picture tube Winding.
Choke:—C45. Use 400v P.I.V. Diodes.

R106 T.V. Power Transformer for Philips T.V. Kitsets

This type similar to R105 but less Picture Tube boost taps. Main Fils. 12.6v C.T. @ 5A.
220v @ 420mA D.C. Voltage Doubler Rect.
230:106v @ 420mA D.C.
:12.6v C.T. @ 5A (2 windings 6.30v @ 5A each).
:6.3v @ .3A Picture tube winding.
Choke:—C45. Use 400v P.I.V. Diodes.

R108 Small Stereo Headphone Power Transformer

250v @ 22mA D.C.
230:110v @ 22mA D.C. Voltage doubler Rect.
:6.3 @ 0.86A.
Choke:—C41. Use 400v P.I.V. Diodes.

R110 T.V. Power Transformer. For Philips T.V. Kitsets

This transformer uses full wave bridge rectifier. Requires no limiting resistor unlike equivalent voltage double types, also has advantage of no insulated capacitor and lower ripple output with smaller choke.
Output 220v @ 420mA D.C.
230:172v @ 420mA D.C. Full wave bridge Rect:
:12.6v C.T. @ 5A (2 only 6.3v winding @ 5A).
:6.3v @ .3A Picture tube winding.
Choke:—C50. Use 400v P.I.V. Diodes.

R111 T.V. Power Transformer

Similar to R110 but for R.C.A. type Kitsets.
260v @ 350mA from Rect.
230:207v @ 350mA D.C. Full wave bridge Rect.
:12.6v C.T. @ 5A (2 only 6.3v windings each 5A).
:6.3v @ 0.6A. Picture tube winding.
Choke:—C42. Use 400v P.I.V. Diodes.

R112 Oscilloscope Power Transformer

R.T.V. & H. 1963. Calibrated.
230:110v @ 80mA D.C. Full wave voltage doubler.
:6.3v @ 2.4A.
:6.3v @ 1A.
:6.3v @ 1A.
Use 400v P.I.V. Diodes.

BEACON RADIO LIMITED

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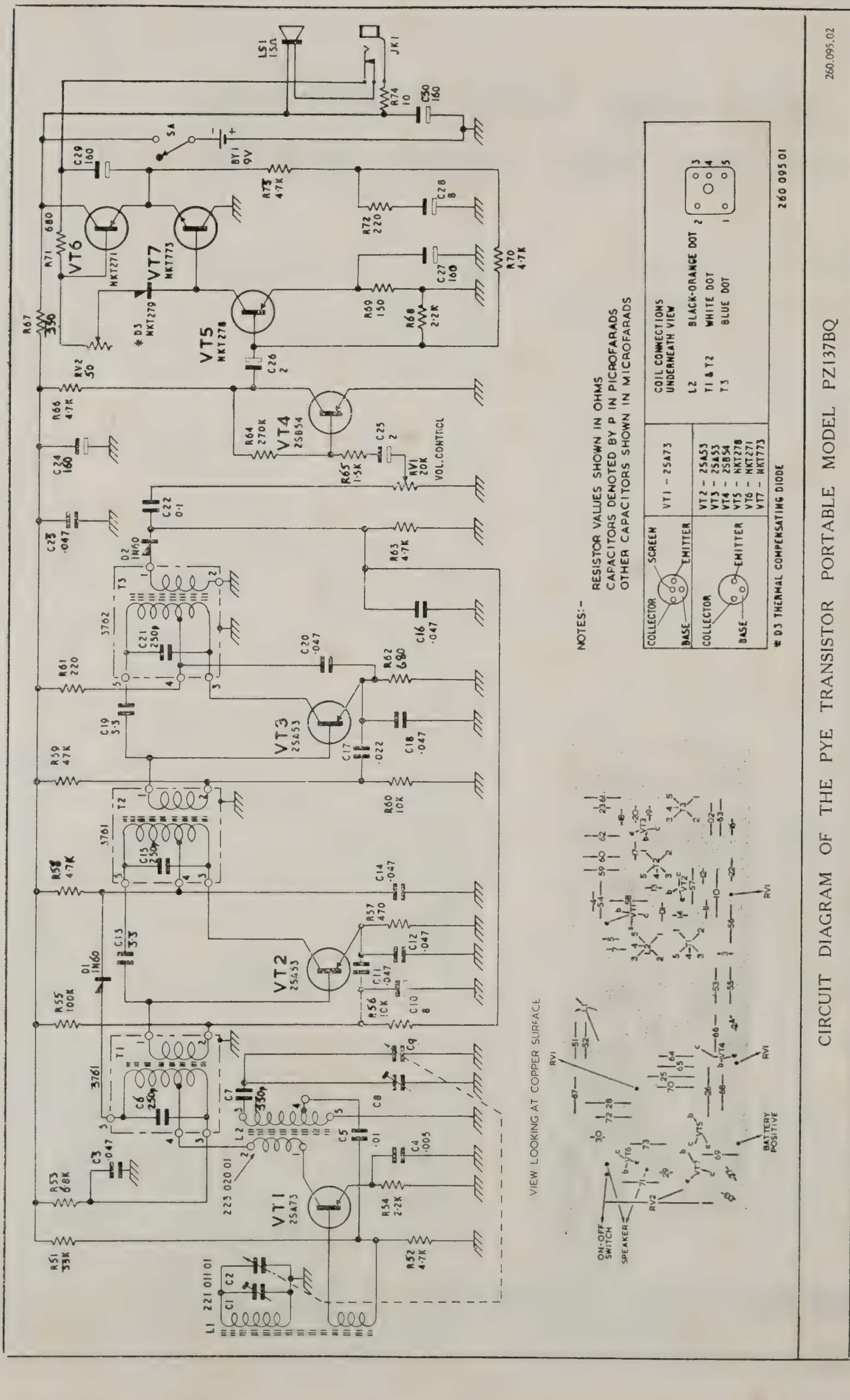

CIRCUIT DIAGRAM OF THE PYE TRANSISTOR PORTABLE MODEL PZ137BQ

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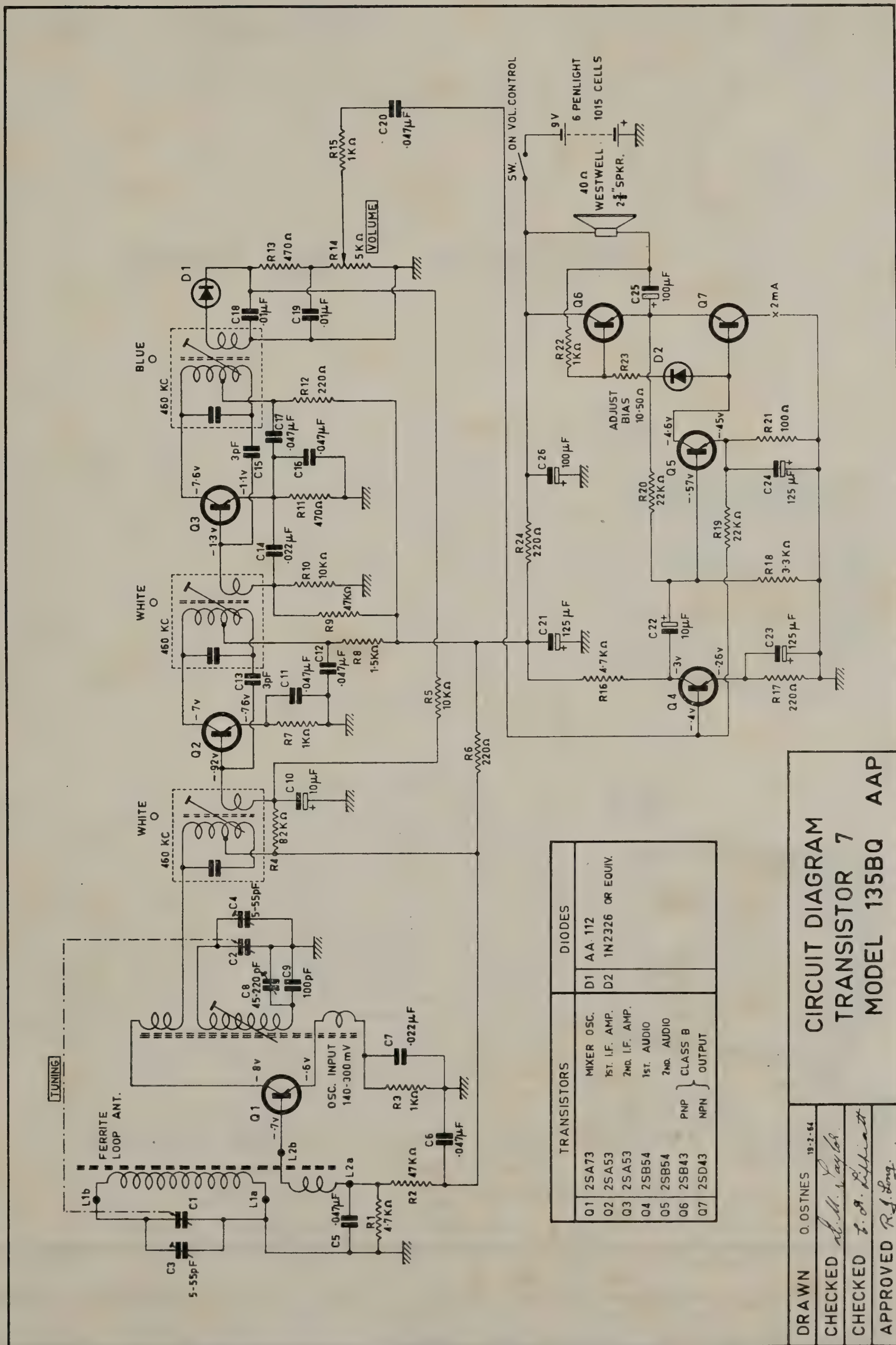
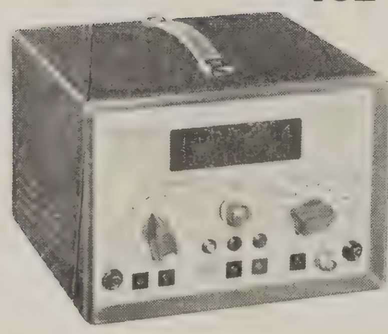


ENQUIRY CARD AD. 13

Advance timer counters

TC2



1Mc/s Timer Counter

Display Four edge-lit in-line indicators with $\frac{3}{4} \times \frac{3}{8}$in numerals with decimal points. *Accuracy* $\pm$ one count $\pm$ accuracy of standard. *Display resetting* Automatic, manual or by positive pulses. *Frequency measurement* Range 0 to at least 1Mc/s. *Gate times* 0·001, 0·01, 0·1, 1 and 10s. Decimal point automatically positioned for display in kc/s. *Sensitivity* Normal input 10c/s to 1Mc/s. Sinusoidal signal between 200mV and 250V r.m.s. Non-sinusoidal signal not greater than 400V pk. V.L.F. input 0 to 10kc/s. Signals between +2 and +50V pk. *Input impedance* Normal input 100kΩ shunted by 30pF. V.L.F. input 5kΩ approx. *Time measurement* 3μs to 10^5s. *Period measurement* From 1 to 10^5 periods. *Counting* 1 to 9999 regular or random pulses. *Frequency standard* INTERNAL 1Mc/s crystal oscillator, oven controlled at 65°C. Accuracy 1 part in 10^6 at 25°C ambient. $\pm$5 parts in 10^6 from 0 to 35°C. EXTERNAL Any sinusoidal signal between 1kc/s and 1Mc/s of amplitude between 1 and 10V r.m.s. or suitable pulse signal. External gate control available. *Check* Self-checking facilities incorporated. *Operating temperature range* 0 to 35°C ambient. *Power requirements* 100 to 125V or 200 to 250V, 45 to 100c/s, 35W. *Dimensions* 8½in (22cm) wide × 6in (15cm) high × 7½in (19cm) deep. *Weight* 12½lb (5·7kg).

TC10

10Mc/s Transistorised Timer Counter

Display Eight edge-lit indicators (7 digits + caption) with automatically positioned decimal point. *Accuracy* $\pm$1 count $\pm$ accuracy of standard. *Display resetting* Manual, automatic or pulse. *Frequency measurement* Range 0 to at least 10Mc/s. *Gate times* 0·1, 1·0 or 10s with caption and decimal point; 0·01 and 0·001 without. *Sensitivity* High impedance (10c/s to 10Mc/s) 100mV to 250V r.m.s. or non-sinusoidal inputs up to 400V pk. Low impedance (10c/s to 10Mc/s) 100mV to 6V r.m.s. into 50/75Ω. V.L.F. (0 to 10kc/s) 2V to 50V into 5kΩ. *Time measurement* From 0·5μs to 10^8s. *Period measurement* 1, 10, 10^2, 10^3, 10^4 or 10^5 cycles of the input waveform with 10^7 p.p.s. timing. *Counting* 1 to 9999999 totalling over any period. *Frequency standard* INTERNAL 5Mc/s crystal oscillator HCD15 oven controlled at +50°C. Accuracy $\pm$2 parts in 10 over the range 0 to 45°C. EXTERNAL Any sinusoidal signal from 1kc/s to 1Mc/s of amplitude between 1V and 10V r.m.s. or suitable pulse signal. *Check* Self-checking facilities incorporated. *Operating temperature range* 0 to 40°C (ambient). *Power requirements* 90 to 130 V and 200 to 240V, single phase. 40 to 100c/s, 40W. *Dimensions* 18in (45·7cm) wide × 13in (33cm) high × 11in (28cm) deep. *Weight* 35lb (15·9kg).

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FROM THE COMPREHENSIVE RANGE OF *Advance* INSTRUMENTS AND EQUIPMENT

SERVICEMAN'S COLUMN

Conducted by J. Whitley Stokes

It is rather exasperating when after putting in quite a lot of time chasing and finally tracking down a particularly erratic type of intermittent fault in a TV. chassis, to receive shortly afterwards a factory service bulletin mentioning the very same trouble. Such was the case recently when after locating no less than three defective condensers in a well known make of TV. set less than 12 months old, I received a service bulletin, which, although not referring specifically to any particular model, gave details of possible symptoms resulting from ageing electrolytic capacitors.

The only good thing about learning the hard way is that one is not likely to forget in a hurry, whereas there is always the temptation to put service bulletins on the file after a quick read through with perhaps the thought "Oh yes, we know all that." Not that I'm above referring to these bulletins particularly where trouble on a new model is first encountered. Quite the reverse in fact as, provided such information is received soon enough it can often save much time and trouble. At the same time I can't help shaking my head over faults occurring in recent models due to the use of inferior or inadequately rated components. For example the use of ceramic bypass condensers with a voltage rating of **25 volts** is to my mind just asking for trouble. I'm not even too happy about 125 volt ratings on some polyester condensers for that matter either. Yes, it looks as though the cheapening process has set in for I recently heard one manufacturer of TV. receivers is reverting to the transformerless power supply technique. Just as I was thinking the transformer powered designs had come to stay too!

A question many servicemen would like an answer to:— Just what is a serviceman supposed to reply in response to that oft-repeated question from the owner of a TV. set. "Surely it shouldn't have given trouble so soon?"

\+ \+ \+

We hear a lot about rising costs these days but even so I must admit to getting a bit of a shock when comparing the prices of certain loktal type valves on a recently received valve price list. Two types in particular showed a staggering jump as under —

EF22 from £1/6/0 to £2/5/0
ECH21 from £1/10/6 to £3/2/2

As a matter of interest I worked out the cost of a complete set of valves for a typical receiver employing this series

ECH21	£3	2	2
EF22	£2	5	5
EBL21	£1	6	10
7Y4		15	6
Total	£7	9	11

Roughly about twice the second-hand value of the receiver. It is these enormous increases in prices which make the repair of such sets a non-economical proposition in many cases. It also causes a search for lower priced substitute valve types. As most servicemen know the EF22 may be replaced by an American made 7A7 or 7B7 with a saving of at least £1 or if an English made one is available the saving will be even greater. The ECH21 may be replaced by a 7J7 with a saving of nearly £2. The 7S7 which was another substitute is seemingly no longer available. In both cases it should be mentioned that it is necessary to make a small alteration to the socket connection, which consists of removing the link between pins 4 & 7 and earthing pin 7. If neither 7J7 nor 7S7 is available an ECH81 may be used if the socket is changed to a noval type. This is not as big a job as it sounds, however averse one may be to drilling out rivets, and allowing 15/- for the extra labour involved is still little more than the price of a 7J7. Another aspect is that the ECH81 will presumably be available for many years to come as it is still a "new equipment" type.

I have always regarded it as the duty of manufacturers not only to provide service information on their products but also to make such information readily available. Nowadays one example of most manufacturers' thinking is that they permit circuit diagrams and other data to be published in the pages of R.E. & C. This is a far cry from the early days of radio when service bulletins were marked "Strictly Confidential" and restricted to distribution amongst franchised dealers only. Then as now nothing is to be gained by adopting such a policy. The only possible cause for differences of opinion is to just how long a manufacturer should be expected to provide information on older models, and this brings me to a recent experience.

I was lacking one particular service manual of an early model TV. receiver although possessing the later manuals of this particular manufacturer. So when requesting a copy of this early diagram and being informed that such was no longer available, I

must admit to being rather taken back. After all was it expecting too much for a manufacturer to supply information on a product which was not five years old and which there must be many thousands still in use? I think not. Surely it wouldn't have been impossible to run off a copy particularly as the "manual" consisted of a single folded page.

What do I think a reasonable time limit would be? Ten years. What do you think?

\+ \+ \+

Two readers, T.D.K. (Wellington) and R.C.M. (Wainui-o-mata) have drawn my attention to a misstatement appearing in this column in the January issue. The point concerned the video detector polarity in the British 625 line TV. system.

I stated that positive modulation is used in both the 405 and 625 line systems. This is, of course, incorrect as the new British U.H.F. transmissions follow the C.C.I.R. standard in that negative modulation is employed.

Provision is made in the receiver switching system to change the detector polarity accordingly.

The main point of difference in the British 625 line system is that the sound I.F. carrier is spaced 6 MC from the vision carrier giving a sound I.F. of 6 MC compared with the 5.5 MC of the C.C.I.R. standard.

To T.D.K. and R.C.M. my thanks — to any readers who may have been misled, my apologies.

CASE HISTORIES

Ultimate RDM Explorer transistor portable

Symptom — whistling and burbling noise.

Cause — instability or oscillation of RF stage.

Remedy — add 100k $\frac{1}{2}$ watt resistor across terminal 2 and 3 of RF primary coil. Check to see if anti-parasitic choke is included. This choke is connected directly in series with base of RF transistor 2N544 on later production sets and may be required on earlier models.

Autocrat 21'' TV. 1960 model

Sympton — sudden loss of vertical scan.

Cause — failure of R101, 330k $\frac{1}{4}$ watt resistor connected from B + boost to PCF80 vertical oscillator plate.

Remedy — use $\frac{1}{2}$ watt or 1 watt for longer life. These remarks apply equally to any brands of receivers using the EDAC 63CW21 kit.

Astor 235W (and any models using T22x chassis)

Symptom — erratic frame hold, poor frame linearity which can not be corrected with linearity controls. Reduced height.

Cause — O/c in C58, 70μF 20V cathode bypass on ECL85 frame output.

Remedy — 100 μF 25V may be used for replacement as there is enough room on P.C. board for a larger component.

Sympton — erratic frame and line hold.

Cause — leakage in C37, .1 μF 25V screen bypass on ECH84 sync separator.

Remedy — use .1 μF 400V polyester for replacement.

Symptom — erratic line hold with greatly reduced locking range.

Cause — O/c in C67, 2μF 20V cathode bypass on reactance valve.

Remedy — use .1 μF 400V for replacement and reset line oscillator coil slug.

The R. E. & C. Experimenters' 6" Tv. Receiver

Part IV

by Irving Spackman

"A Simple Band 1 Tuner"

Firstly we wish to correct a small error on Page 13 of last month's copy. About 2/3 of the way down the right hand column on this page are 4 equations with the words "does not equal" etc. along side them. These three words should read "approximately equal to" etc. This slight error will appear odd, when read in conjunction with the paragraph following these equations. The information in the paragraph is correct. We would ask our readers to amend their copies accordingly.

This month in the fourth and final part of this series, we will discuss and describe a simple tuner for the Band 1 Channels 1, 2 and 3. It is however a single channel device, and must be tuned up for the desired channel. At this juncture we have not developed a Band 3 (Channel 4 to 9) tuner of similar construction because the higher frequency operation demands greater care in layout, coil construction and alignment to achieve good results. If however sufficient interest is evident we will seriously consider such a project.

Choice of Tubes for the Tuner

We have used an ECC85 or alternatively a 6BQ7A in the R.F. stage operating in what is called the "Series Cascode" configuration. More will be said of this a little later. This tube type does not have quite as much gain as some other twin triodes also commonly used in current TV. tuners. However, and this is a big point, tubes such as the ECC88 or ECC189 with their higher gain are also more critical with respect to layout, shielding and by-passing, to avoid instability troubles. Therefore these are not recommended for use by constructors, who may not have had much experience in constructing equipment, operating at frequencies at 50 megacycles and higher. With the medium gain R.F. stage, we have used a high gain low noise mixer tube, the pentode section of an ECF86. Included in the same envelope as the pentode is a suitable triode for oscillator service.

Details of the Circuit

The 300 ohm feedline is link coupled into the first tuned circuit L2 which is resonant with the input capacity of the triode first stage, damped by a 4.7K resistor, and tuned with an iron dust slug. The first tube operates as a triode amplifier, but neutralisation is not required because it is operating into the cathode circuit of the second stage. The impedance of the cathode of the second stage, a grounded-grid amplifier is very low, and therefore the gain of the first triode stage is low. The second triode cathode is directly coupled to the anode of the first triode, with common anode current

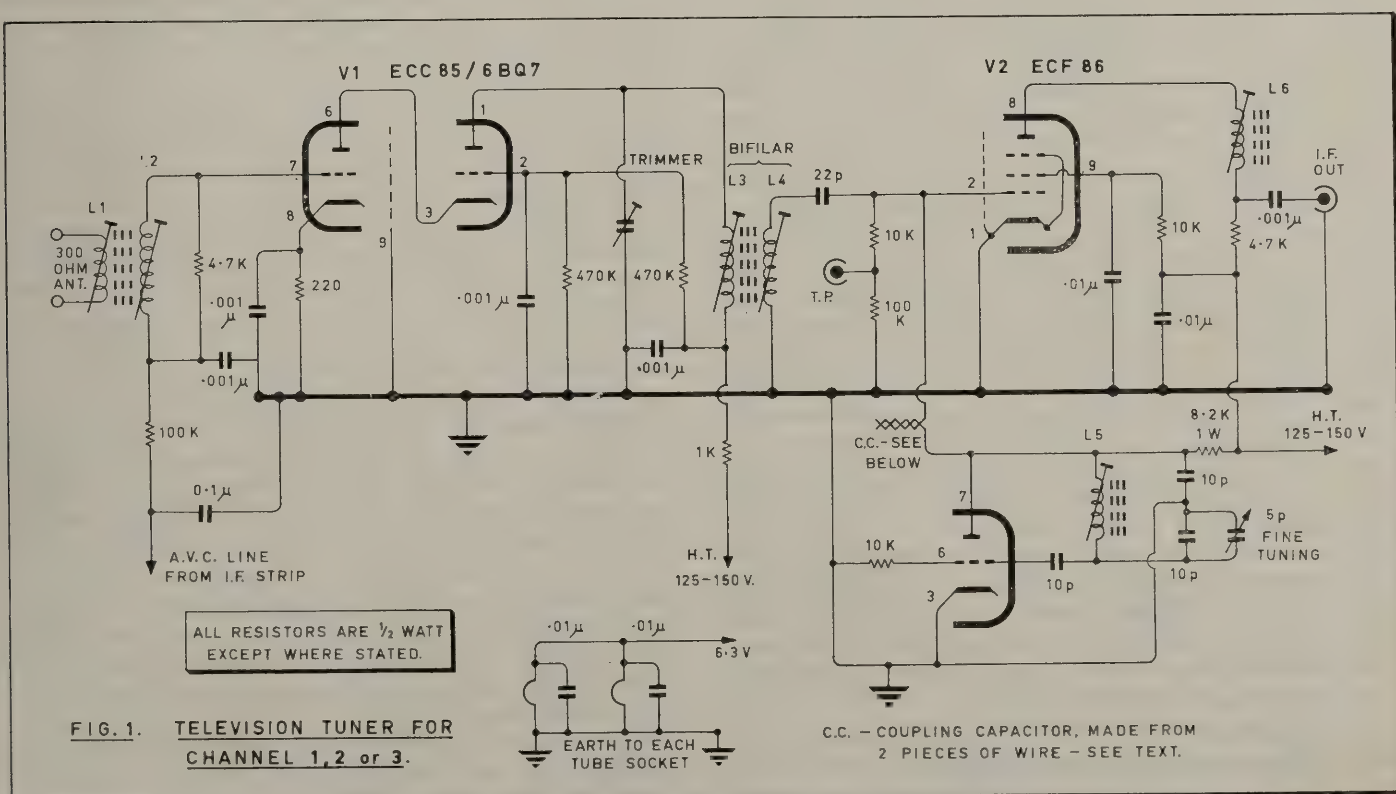

FIG. 1. TELEVISION TUNER FOR CHANNEL 1, 2 or 3.

flowing through both sections. The grid of VIB is biased, with two 470K resistors forming a voltage divider, at about ½ the supply voltage and is "grounded" for R.F. with the bypass capacity. AVC negative voltage is applied to Vla grid via L2 and effectively controls the gain of both sections. The anode circuit of the R.F. stage, is a bifilar wound coil, resonant with the output capacity of VIB. It is not damped with a resistance because the plate resistance of VIB is quite low. The choice of a bifilar wound coil for L3 L4 as was explained in previous articles in this series enables the various tuned circuits to be kept as complete integral units with their respective amplifying tubes. The grid leak across the grid circuit of the ECF86 pentode is divided into 2 parts to provide an I.F. injection point for alignment purposes.

The ECF86 pentode anode circuit is resonant at the I.F. frequency and is damped and tuned in accordance with the data we developed last month.

The triode section of this tube operates as a colpitts type oscillator. This type of oscillator is simple and reliable, and generally free from problems, providing it is properly constructed.

Constructional Details

Looking at Fig. 1 readers will note that only one earth point is shown in conjunction with the R.F. amplifier. This earth point should be a solder lug mounted under the screws securing the socket to the chassis. The screw closest to pin 9 of the socket should be selected. In addition a shield made of thin copper, brass or even tin plate should be soldered across the socket from side to side of the chassis so that the grid coil is completely isolated and shielded from the anode coil. This shield should be soldered to pin 4 (the earthed filament) the centre spigot, and pin 9 and earthed to the solder lug alongside the socket.

As mentioned before, L3 L4 is bifilar wound and slug tuned to resonance. The primary winding is decoupled with a 1K ohm resistor, and a .001 mfd. capacitor earthed back to the socket of VI. The secondary of the bifilar wound coil is coupled via a capacitor to the grid of the ECF86 pentode section whilst the other lead is connected to an earth lug alongside the ECF86 socket. All other earth returns for the ECF86 should also be made to this point. The output coil of the mixer L6, is slug tuned to resonance, and the connection to the I.F. strip is via a short length coaxial cable as shown in the circuit in Part 1. The capacity of the cable plus other capacitance intentionally connected across it, constitutes the output capacitance of a pi-section network. The input capacitance of this network is the plate to cathode capacity of the ECF86 pentode section plus other stray capacitance, amounting to something of the order of 10pf.

The oscillator inductance L5 is tuned by two capacitances in series, with the centre tap connected to earth. The fine tuning control is a small variable capacitor connected across the capacitor on the grid end of the oscillator coil. The plate of the oscillator coil is coupled to the grid of the mixer with a small capacitance, and this is made from 2 pieces of thin hookup wire approximately one inch long, twisted together.

The tuner is assembled on a small aluminium chassis 7'' long, 3'' wide 2'' deep. These are commercially made and readily available, but any small chassis of similar type would suffice.

The layout follows logically along the chassis in roughly the manner of the circuit. The shield across the R.F. amplifier completely divides the chassis. The antenna input connector is on one end whilst the coaxial output socket is at the other, together with a socket for connection of the filament and H.T. leads.

The small trimmer capacitor (fine tuning) can either be mounted through one side or the top depending on the particular constructional pattern of the remaining equipment.

The coils are wound on O.B.A. slug-tuned formers similar to, but shorter than the ones used for the I.F. strip. In this case, however, the shield cans are mounted separately, by bending the mounting tabs outward and securing to the chassis with small P.K. screws. This method of mounting enables each coil to be checked for resonance at the desired frequency with a G.D.O. if such an instrument is available. Then the shield can be screwed down and final adjustments made to the tuner with a wobbulator, signal generator or "on the air' signal.

The oscillator coil is designed for frequencies in the 80 to 100 megacycle region and consists of 6 turns of 20 guage enamel or tinned copper wire space wound to fill ½''. The mixer output coil is similar to the input coil of the I.F. strip, i.e. L1 in the circuit in Part 1 and is 10 turns of 30 guage enamelled or poly-varnish wire, close wound. The bi-filar wound interstage coil is 9 turns of 24 guage, bi-filar wound, i.e. there are 18 turns total. The input coil consists of 10 turns of 24 guage wire, close wound with a link of 2 or 3 turns of the same wire spaced about 1/16th. of an inch from the earth end of the coil.

This completes our discussion and description of the tuner, and with it also brings to an end our series on the Experimenters TV. Receiver.

There may be some parts we have not covered adequately, whilst we may have elaborated too much on others. However, this is designed as an experimenters receiver, and it is intended that the reader should learn from his work (and mistakes). Do not be frightened to alter or modify some part of the circuit, if you feel it will make an improvement. In all cases the final results will depend mainly on the amount of time and care you spend on layout, wiring and alignment of the various circuits. Incidentally once you finally have the receiver going to the point where you can get a picture, don't forget you must take out a TV. licence to comply with the law.

MEDIUM POWER SEMICONDUCTOR RECTIFIERS — continued from page 16

Transformer Output Voltage

The DC output **from the rectifier** is made up of

$$V_{DC} + \text{choke DC drop} + \text{rectifier drop}$$
$$= 50 \text{ volts} + 2A \times 2 \text{ ohms} + 2 \times 1 \text{ volt}$$
$$= 50 + 4 + 2$$
$$= 56 \text{ volts}$$
$$V_{RMS} = 1.11 \times V_{DCO}$$
$$= 1.11 \times 56$$
$$= 62 \text{ volts approx.}$$

(It is assumed here that the choke has a DC resistance of 2 ohms and each rectifier arm has a constant 1 volt drop.)

It can be shown that the CWV (PIV) that a rectifier must withstand is

$$1.57 \times V_{DCO}$$
$$= 1.57 \times 62$$
$$= 100 \text{ V}$$

The peak current will be less than 1.57 I_{DC} say $1.5 \times I_{DC}$ at the worst $= 3$ A

Comparison

It will be seen that with inductive filtering higher voltages are called for but lower values of capacity and lower peak currents result.

Figure 8 shows the effect of 1 or 2 section arrangements upon the attenuation factor. Published curves (2) show the effect of an additional stage.

Conclusion

It is hoped that the examples given above show that application of simple formula and the use of the material not very accurately presented here can take much of the mystery out of rectifier circuit design.

The approximate means of arriving at the various maximum parameters — transformer voltage, peak voltages and peak currents — should allow the intending rectifier user to better select or order a rectifier providing these values are stated with the order!

The references given should be followed up by the intending user as much of value has had to be omitted from this review. In particular, the Laboratory is indebted to the Mullard publication (2).

Thanks are due to the Director-General of Health for permission to publish this paper.

—List of references appears below

STOP PRESS!

"OSCAR 3 IS LAUNCHED"

As we go to press, we have received the news that "Oscar 3", the first amateur repeater type satellite was successfully launched into a Circular Orbit 502 miles above the earth on Wednesday, 10th March.

The orbit is at an angle of 70 degrees to the equatorial plane. The first northerly crossing of the Equator by the satellite's track occurred at 7:30 a.m. N.Z. time at a point 300 degrees west longitude. At the time of writing (the ninth orbit) the orbit time has been calculated at 103½ minutes, and each successive track is progressing westward by approximately 26 degrees. The HI Beacon on 145.850mc/s is functioning with telemetry indicating all is well on board the satellite. The translator channel is also working although no news yet has been received of communication via the equipment. However the continuous tracking beacon on 145.950 mc/s has not been detected as yet.

Full coverage will be in the next issue.

—I.H.S.

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ENQUIRY CARD AD. 18

PHILIPS CARBON POTENTIOMETERS 23

These potentiometers satisfy the ever growing demand for first-rate, yet moderately priced, resistance controls of reduced dimensions. Notwithstanding the small size, the construction is quite rugged and warrants a fully satisfactory operation for many years, whilst the electrical properties are outstanding.

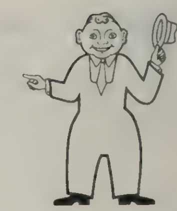
The carbon track is adequately dampproof and resistant to wear. The track noise is exceptionally low and will not show any perceptible increase after prolonged use, even under adverse climatic conditions. As a consequence of the permanently low contact resistance between carbon track and rotor, excellent results are also obtained — for instance in transistor sets — when the potentiometers are not employed as a voltage divider but as a variable resistor with a current-carrying sliding contact.

Thanks to rigorously checked mass-production, the quality level is not only remarkably high but also consistent.

Tandem potentiometers, which are available for stereophonic recording and reproduction, ensure adequate equality of the two signals both in volume and tone.

The potentiometers are available with internationally approved **double-pole mains switches,** either the well-known single-throw **rotary** switches or — in the case of single items only — **push-pull** switches. These latter are of a very efficient and advanced design, and they operate independent of the resistance control so that, consequently, the wear of the carbon track is practically eliminated.

Each Philips carbon potentiometer has been tested three times and complies with international standards. It is guaranteed for long life performance.



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12 Volt car battery supply. 11 Watts audio output. Response 2dB 50 c/s to 10 kc/s. Inputs 1 low impedance, 1 high impedance. Output 4/8/16/500 ohms. Distortion less than 5%. 8 transistors.

SEE LAB REPORT IN FEB. 1964 OF "R. & E." PAGE 32.

ENQUIRY CARD AD. 19

MANUFACTURERS & DISTRIBUTORS

REDFERN RADIO

113 Great North Road, Glen Eden, Auckland

Mr. Ralph Slade, Managing Director of Electronic Development and Applications Co. Ltd. (EDAC), died on 17th February at the age of 61 years. He was a pioneer of Radio and Electronics and, over the years has come to be regarded as one of the fathers of the industry in New Zealand.

Mr. Slade was born in Hornby, Christchurch, in 1904 and was educated at the Timaru Boys' High School and the University of Otago. He commenced his business life as an engineering cadet with the N.Z. Post Office in Dunedin, whilst still at University. In 1927 he was transferred to the Post Office Laboratory in Wellington, a position he held until he resigned in 1929 to join the Philips organisation.

During his 36 years with Philips he held a series of positions — Service Manager, Technical Manager, Factory Manager and Commercial Manager.

In 1954, Mr. Slade's devotion to the advancement of the science of electronics in New Zealand resulted in the formation of a sister company to Philips known as EDAC, of which he was appointed Managing Director, a position he held until his untimely death.

During the period of the Second World War (1940-45) Mr. Slade was appointed Director of Radio Production for the Ministry of Supply. Mr. Slade was also a member of the N.Z. Electronics Institute, the N.Z. Amateur Radio Transmitters' Association, the Technical Advisory Committee of the Dominion Physical Laboratory and the Radio Interference Technical Advisory Committee. Also, he was an ex-chairman of the Wellington Radio and TV. Manufacturers' Association, past president of the N.Z. Radio and TV. Manufacturers' Federation, of which he was recently made a life member, and was the Wellington nominee of the Manufacturers' Research Committee. He was also a past member of the Council of Scientific and Industrial Research.

A keen amateur radio transmitter Mr. Slade was the first "Ham" in N.Z. to hear American amateurs on 150 metres (in 1921), and in 1924 he made history as the first amateur to transmit morse signals on 40 metres to England.

COMMUNICATIONS AT NEW MANGERE AIRPORT

The control and turn around of aircraft at an international airport, such as Mangere, demands a high standard and reliability of communications equipment. Coordination and general control of such departments as catering, engineering and flight control, require rapid and reliable communication between one another.

In the DIALACALL system, provided for Air New Zealand Ltd., by Ultra Violet Services Ltd. provision has been made for dial control loudspeaking intercommunications units, rather like loudspeaking telephones and with provision for 3 simultaneous conversations, switching to one another via a control automatic switching unit. A master control console indicates all circuits which are engaged and provides for over all paging and 'break in' facilities. Satellite speaker units dialling engaged units receive an engaged tone; thus preventing interruption, as is the case on more conventional loudspeaker systems.

Distances between the various buildings at Mangere are considerable, involving in some instances as much as half a mile. Add to this the fact that most of the buildings are themselves large and the difficulty of tracing individuals, during their travels, becomes a very real one. Loudspeaking telephones that can announce, immediately, who is required are then used to great advantage. In an aircraft turn around time of some 20 minutes every minute counts. Cabling for this all master system has been reduced to 5 conductors and interconnecting of satellites eliminated.

Under the same contract, an automatic reference system is to be provided between passenger check in positions and the appropriate clerical section. To minimise waiting time, this system provides for automatic queueing of the calls, should a particular unit be engaged. As soon as the engaged unit is cleared, the next call, the correct order of priority, is automatically connected. This means that clerical staff, dealing direct with the public, are not required to spend long periods waiting on a telephone, whilst the next in the line of passengers stands champing at the bit!

Other smaller loudspeaking intercommunications systems are also to be provided and a large area selective paging system, to cover the large hanger areas will all tend to ease the many problems of administering a large international airport.

Design Engineers:

Robt. Adams, A.M.I.E.E.E.
Don Elliott, A.M.S.E.E. Lond.

RUSSIAN AMATEURS DESIGNING SYSTEMS

Russian amateurs, it is believed, have designed electronic instruments which are finding widespread use in medicine, metallurgy and agriculture.

There is a battery operated, pocket-sized two-way "videophone" for cosmonauts and other users. The equipment, developed by K. Samoilikov has a 30 by 40 millimetre screen and uses 22 transistors, six diodes and a valve.

A "white noise" audio generator, developed by the amateurs, Lobatsevich and Ratynsky is being used by dentists to kill pain.

Unplotted buried cables are a source of many difficulties during earth-moving work, and the amateur N. Lubyanistky has developed a transistorised cable detector, consisting of a tank circuit mounted 20 centimetres above the ground on the earth digging machine with low-frequency amplifier and multivibrator with an illuminated display.

An electronic counter with individual record-keeping facilities for use with automatic milking machines has been developed by Chemeris and Lukovsky. The counter measures time of travel of milk spurts at constant speed and pressure and consists of a pick-up element signal converter, rectifier and impulse counter.

Patent applications filed in the United States on behalf of Russian engineers have increased in the past six years from about an annual total of zero to about 100. with more than 300 applications pending.

ENQUIRY CARD AD. 17

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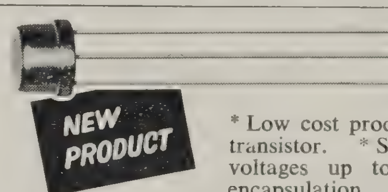

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LISTENING POST

by michael lawrence

SUNSPOT NUMBERS

With the sunspot minimum occuring in the last half of 1964, the sunspot numbers are again on the increase. This will result in a gradual rise in the maximum usable frequencies during the next five years or so, and by 1970, it should be no trouble to receive strong signals from Europe on 25Mc/s whereas, at present with low sunspot numbers, one is lucky to get good reception on a frequency as high as 17Mc/s. However, this increase will also be accompanied by more ionospheric disturbances which will result in more frequent "fadeouts".

The average sunspot number for February 1965 from Zurich was 14.3 and, by August, it is predicted that this will have risen to 22.

On the first Saturday of each month in the programme "Swiss Shortwave Merry-go-round", the S.B.C. broadcast the daily Zurich sunspot numbers for the previous month. If the first Saturday happens to be the 1st, 2nd or 3rd of the month, then the reading is carried over to the next week. Approximate times for the broadcasts are 0805, 0950, 1250, 1405, 1550 and 1935 GMT and the current frequencies for the N.Z. transmission at 0950 are 21,520, 17,820 and 15,305Kc/s.

MORSE PRACTICE

For those interested in learning or polishing up on morse code, the RNZAF operate a morse practice transmission from ZKF at Ohakea from Mondays to Fridays. Transmissions start at 0615 GMT with a speed of five words a minute, increasing by five words a minute every 15 minutes until 0730 when the speed is 30 words a minute. The station signs off at 0745 GMT. Frequencies are 3,236 and 6,885Kc/s.

STATION NEWS

U.S.A. The following is the latest schedule from Armed Forces Radio and Television Service:—

West Coast Transmitters: 2130-0245, 17,820; 2130-0330, 15,410; 2230-0700, 11,790; 0315-1245, 9,765; 0400-0800, 9,700; 0700-1030, 15,210 (Philippines relay); 0730-1630, 5,965; 0800-1630, 9,695; 1300-1500, 11,705.

East Coast Transmitters: 1430-1800, 21,650; 1430-2245, 15,225 and 15,280; 1800-2245, 11,905.

News bulletins are broadcast every hour on the hour and "Conference Call", in which programme information and frequency changes are announced, is broadcast daily at 0730, 1430, 1745 and 2230 GMT.

FIJI. The Fiji Broadcasting Commission has been heard to open their English language transmission at 1800 GMT on VRH4 4,756Kc/s with 13 minutes of local news at 1817. VRH8 on 3,230Kc/s is in use at 0700 GMT with news at 0710.

HAWAII. The Voice of America transmitters at Honolulu are on the air as follows with a power of 100KW: 0900-1230, 9,650, 11,845; 1300-1630, 5,975, 6,125; 2130-2230, 11,950, 15,345.

The United Nations Radio has replaced 9,560Kc/s with 11,845Kc/s in their relay from Honolulu to New Zealand.

FRANCE. O.R.T.F. in Paris has been heard at good strength between 1830 and 1845 GMT on 11,845 Kc/s when it broadcasts English news to Africa.

PAKISTAN. Radio Pakistan broadcasts a musical and spoken programme in English from 1945 to 2030 GMT on 9,740 and 7,135Kc/s.

WINDWARD ISLANDS. The Windward Islands Broadcasting System has been heard after about 1600 GMT broadcasting cricket commentaries during the recent Australia v West Indies cricket tour, the frequency being 11,895Kc/s. On days when there is no cricket, the transmission opens at 1959 and relays the BBC news at 2000 GMT. Another frequency reported to be in use is 15,085Kc/s.

GERMANY. Radio Berlin International has been reported in English on 9,560 and 9,645Kc/s at the following times: 0100-0130, 0230-0300, 0345-0415, 0445-0515.

HOLLAND. The following English language schedule of Radio Nederland came into effect on March 7th:

Mondays - Saturdays. To Australia and N.Z.: 0700-0750, 9,715, 6,025. To South Asia: 1400-1450, 17,830, 15,425, 6,020. To Africa: 2000-2050, 11,970, 9,590. To Europe: 2000-2050, 6,020. To Europe and North America: 2100-2150, 11,730, 9,590. To North America: 0400-0450, 9,715, 6,085.

Sundays. To N.Z. and West Indies: 0130-0150, 11,935, 9,715. To Australia and S. Asia: 0530-0550, 6,025, 11,730, 9,715, 9,525. To Europe and S. Asia: 1030-1050, 9,525, 15,425. To Africa, North America and Europe: 1730-1750, 15,220, 15,425, 6,020. To North America and Europe: 2000-2020, 11,970, 6,085, 6,020.

BROADCAST BAND NEWS

The new 1KW station for Taumarunui is to have the call sign of 1ZU and will operate on 1520Kc/s from 1800 to 2100 GMT Sundays to Fridays. After 2100 GMT the station will relay programmes from 1XH.

Station 1ZA in Taupo should be in operation by the end of May. Hours of transmission will be the same as for 1ZU Taumarunui, but after 2100 GMT programmes will be relayed from 1ZC.

THE EFFECT OF WHITE SOUND ON PAIN

*by J. CLUTTON-BROCK**

It has been reported in the U.S.A.[1] that white sound, via a pair of headphones, will produce in a patient sufficient relief from pain to be useful in dentistry. White sound, used in a similar fashion, has also been found to give some relief from pain after surgical operations[2].

Before discussing the question of pain, it is perhaps necessary to have some definition of white sound. White sound is what will be produced by white noise converted to sound in the subject's ear by a transducer having a level response over the whole audible range. Assuming that we can supply white sound to a subject it is necessary to have some method of measuring the degree of pain relief produced. The whole subject of the measurement of pain and pain relief is very difficult and complex, but we have developed in this Department a technique for measurement of what is known as the 'pain threshold.' With this we can measure the effect of various drugs and manoeuvres on this threshold. The pain threshold may be defined as the point at which a potentially painful stimulus applied with increasing intensity becomes just sufficient to cause pain. There are many potentially painful stimuli that can be used for this purpose, but we have been using pressure on a small area of the skin over the shinbone applied by a spring-balance. The pressure is increased steadily and the subject is instructed to say 'Yes' when it just begins to hurt. The point at which this response is obtained is then read in pounds on the scale of the balance[3]. With this technique we are able to show the effect of drugs such as morphia which are regularly used for the relief of pain.

To enable us to investigate the effects of white sound on the pain threshold we were very generously lent, for a long period, by Dawe Instruments Ltd., one of their Type 419 BR White Noise Generators. The output of this apparatus was fed through a Leak TL/12 Plus amplifier with a suitable variable attenuator, so as to have ample reserve of power. The signal was fed to various pairs of headphones which had been calibrated for frequency response at a set voltage into an artificial ear (N.B.S. 6cc. Coupler 9—A). This calibration was very kindly done for us by S. G. Brown Ltd. The output to these headphones was monitored by means of a valve voltmeter. We were also anxious to study the effect of varying the bandwidth of the white sound, and for this purpose the signal was passed through variable filters, both high pass and low pass, which were kindly lent to us by the British Broadcasting Corporation.

In our first series, 21 experiments were performed on 11 volunteers. In 5 of the 11 subjects the pain threshold was raised to a moderate degree by intensities of white sound of something of the order of 90-100 dB above the threshold of hearing. This rise of the pain threshold is roughly of the same order as that produced by a moderate dose of morphia. We then compared this rise of the pain threshold with that produced by distracting the subject's attention. It is a well-accepted finding that distraction can cause a rise in the pain threshold. To produce this distraction, the subject was given a book and told to read it with all the concentration he could muster. The effect of this was, in 4 subjects, to cause almost exactly the same rise in the pain threshold as that produced by white sound.

In certain subjects we found we could produce a very marked rise in the pain threshold by white sound when this was of sufficient intensity to cause pain. This occurred at some 120 dB above the threshold of hearing. This intensity of sound is, of course, dangerous, and may cause damage to the ear if prolonged.

In all the subjects tested, sudden cessation of white sound raised the pain threshold to a high level for a few seconds. This happened even in those subjects where there was no rise in the pain threshold with a steady application of white sound. Apart from this rise the pain threshold fell rapidly to normal on stopping the white sound. We have not been able to produce a rise in the pain threshold by a pure tone at one particular frequency. Reduction of bandwidth of the white sound also reduced the effect. It seemed possible that the effect of white sound on pain might be related to the effect produced by distraction, since white sound is a random signal to which habituation should not occur. It was therefore decided to investigate the effect of random stimuli of some other sort.

Regular stimulation by flashes of light of great intensity but of short duration causes very profound responses by the nervous system which can often be detected in the electroencephalogram. We found that regular stroboscopic stimulation at various frequencies did not affect the pain threshold. In order that this form of stimulation should have a random quality, we triggered the stroboscope by means of a radioactive source. These random flashes of light also failed to raise the pain threshold. Indeed, in one experiment, the rise in the pain threshold produced by white sound was abolished by the simultaneous application of random flashes of light. It did not seem, therefore, that the mere randomness of the stimulus could be the whole explanation for the rise in the pain threshold produced by white sound, though it would be interesting to try random stimuli of some other modalities of sensation. It seems, however, a little difficult to achieve random smells and random tastes with any rapidity, and one's imagination tends to run riot somewhat on the question of random touch.

It may be with white sound that it is not the randomness of the stimulus that is important, but that by saturation of the auditory pathways it causes a stimulus to that part of the brain which inhibits the passage of painful impulses. It is believed that there is an inhibitory system in the brain which can control the passage of the various sensory impulses. It has been shown that this inhibitory system can itself be inhibited by certain drugs, particularly the barbiturates. We have been able to show that the rise in the pain threshold produced by the application of white sound is abolished by the administration.

In these preliminary experiments we were not able to measure at all precisely the quality of the white sound that was actually reaching the subject's ear. Nor was it likely that the bandwidth of the white sound was very wide. We do not yet know how important this is in relation to the effect on the pain threshold. Although the white noise generator produces beautifully white noise, the whole problem of the production of truly white sound is very complex and has been discussed by G. E. Hesse, Electronics Technician in my Department[4]. We are now conducting experiments into this matter using the artificial ear recently designed by Bruel and Kjaer[5].

To sum up, it would seem that the sound we were using (which might be called pale pink) will produce some rise in the pain threshold in certain people, but the rise produced so far has been unreliable, except for the few seconds when the sound was switched off. However, white sound is a purely physical method of reducing pain, is not unpleasant and is apparently without the side effects produced by drugs. We are therefore continuing with the experiments.

Acknowledgments

Some of the findings described in this lecture formed part of a paper read to the Association of Anaesthetics in Dublin in October 1961, and I am indebted to the Editor of "Anaesthesia" for permission to publish them here.

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* Lecturer in Anaesthetics, University of Bristol, and Head of Department.

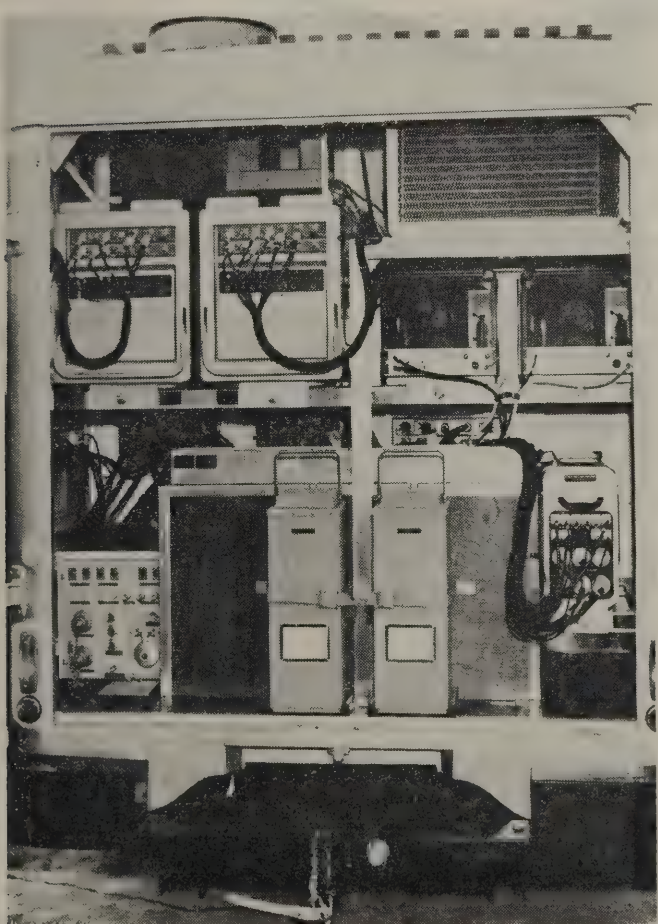
This article first appeared in DAWE DIGEST, June 1963, is gratefully acknowledged.

Outside Broadcast Vehicle For Dunedin *See Cover*

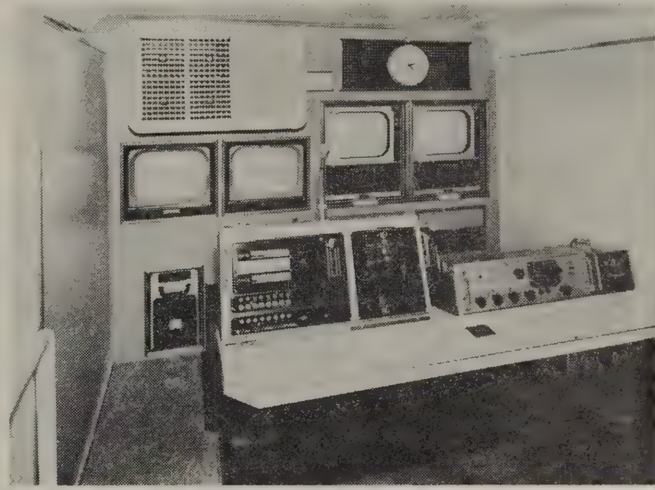
The New Zealand Broadcasting Corporation has awarded a contract to A.W.A. for the supply of a two-camera Outside Broadcast Vehicle for Dunedin. This vehicle is due for delivery in New Zealand in June 1965, and it is hoped that it will arrive in Dunedin in time to be used during the Springbok Tour.

The increasing trend towards the inclusion of more sporting events and local news items in television programmes has led to a growing interest in outside broadcast units in all parts of the world.

Until recently the demand has been for a sophisticated comprehensive three-or four-camera vehicle, capable of carrying out a production with similar equipment to that contained in a comparable studio installation. When televising large events, such as processions, athletic matches, ceremonies etc., a requirement certainly exists for large units employing four or more camera channels. For some television organisations a four-camera unit is not always justified, when considered in relation to the amount of work to be carried out. To cater for such authorities, who still require a television outside broadcast vehicle, a much smaller unit has been developed by Marconi containing only two camera channels, but retaining to a large extent the operational and technical facilities of a four-camera unit. This is the type of vehicle on order for Dunedin.



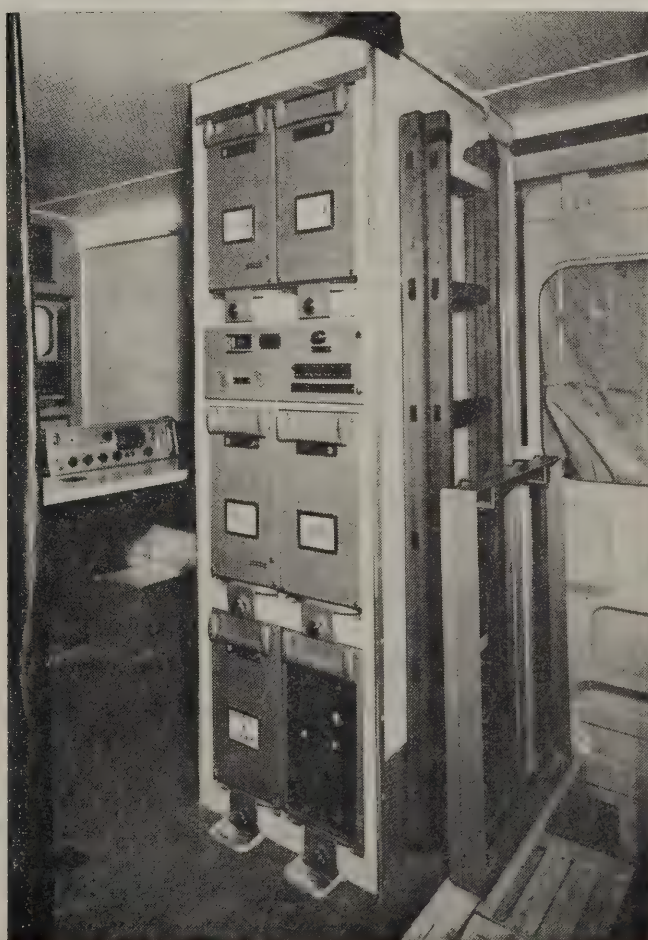
In common with the other O.B. units in service with the NZBC, the two-camera unit employs 4½" Image Orthicon cameras which are identical to those used in NZBC studios.



Above. The production desk. The camera control operator sits on a low bench in front of this. The air-conditioning plant is seen on the upper left.

Lower left: The van with rear doors open giving access to the equipment in the production area.

Below: The equipment rack in the production area, containing the camera control unit, power supply units, communication unit and sync. generators.



ENQUIRY CARD AD. 20

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The new Solartron model CD 1400 is a low cost portable Oscilloscope System employing the latest 5" double-gun PDA cathodoray tube to give large, bright, high resolution displays at all sweep speeds. To provide maximum flexibility both the X and the two Y Systems plug in and drive the CRT plates direct. Power supplies are conservatively rated enabling any combination of plug-in units to be used and allowing for future development of additional units. Two types of cases are available for bench use or rack mounting.

The bench case has a wide carrying handle which may be used as a tilt stand.

For full information on the Solartron CD 1400 Oscilloscope, write to the Sole New Zealand Agents:—

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THE DEVICE TO OUTPACE TRANSISTORS

—continued from page 18

tions. For example it can be utilised in keeping the output voltage of an alternator constant when the amount of current drawn from the machine varies. Because of "wave-form errors" this is difficult to achieve using conventional components.

The other practical application is to computing. The Birmingham team has shown that surface-channel triodes are excellent for carrying out one of the basic operations of arithmetic—multiplication. If two voltages proportional to two numbers are applied to a surface-channel triode it passes a current which is accurately proportional to their product. There are many ready-made applications for a fast, simple "analogue multiplier" like this.

When the dielectric valve is fully developed it will replace the transistor in many roles, and will probably penetrate into areas of electronic engineering which are beyond the reach of transistors. In addition, the two devices should be useful partners in electronic circuits. Dielectric valves can operate from the same low voltages as transistors and they need no heater-power supplies.

This means that all the advantages of valves and transistors can be enjoyed in one piece of equipment without incurring the penalty of having to provide different power supplies for the different devices. We may expect to hear a lot about dielectric valves in the next few years.

ENQUIRY CARD AD. 23

SEE HOW RCA RECEIVING TUBES KEEP GETTING BETTER

1959 —N-132 Cathode Base Material

1960 —S-311 Plate Material

Virtually ideal black-body characteristics for most effective heat dissipation

1961 —Dark Heater

Produces required cathode temperature at a heater temperature 200°K to 350°K below that of conventional heaters

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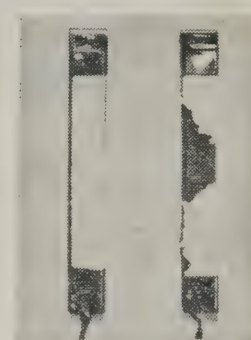
THE BONDED CATHODE



Ends cathode peeling, even after long periods of high-temperature, high-voltage tube operation.

Picture on right is an example of peeling which may occur in nonbonded cathode of a horizontal-deflection-amplifier tube after several hundred hours of operation in a TV receiver.

From RCA research, another major contribution to electron tube performance and reliability: the bonded cathode. Its emissive-oxide coating **will not peel** even after extended service under high-voltage, high-temperature conditions encountered in TV horizontal-deflection-amplifier tubes and damper diodes. Permanent adhesion of the emissive-oxide coating of the RCA bonded cathode improves over-all tube performance and reliability . . . with resultant extension of tube life. Here's why!

THE NEW RCA BONDED CATHODE:

- virtually eliminates peeling of emissive-oxide coating
- reduces grid-to-cathode shorts during life
- reduces cathode interface-type impedance effects during life
- improves stability of cathode-to-grid spacing
- improves anode-voltage-per-mil-spacing safety factor in damper diodes
- transmits heat more efficiently and uniformly — thereby providing more uniform cathode-current density.

The RCA bonded cathode was first applied with outstanding success in beam power tube types 6DQ6-B and 6JB6, and half-wave vacuum rectifier types 6AU4-GTA and 6AY3. This new development is now being incorporated in a growing number of types where service conditions indicate the need.

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VR25

Phasing and Balancing Your Stereo System

—Continued from page 12

ever, the series resistor in the metering circuit would also have to be increased to prevent meter overload. At present the series resistance is selected for a total meter movement of 20 volts, i.e. ± 10 volts from the centre point. Other meters, with differing sensitivities up to 1 mA full scale (i.e. ± 500 μA) can be used with appropriate changes in the series resistance. Many ordinary meters can have the pointer setting shifted to bring the needle to centre scale. These of course, would serve admirably.

Make sure that the speakers are properly phased with respect to the instrument. The details of phasing were covered earlier in the article. In this case the terminal shown as + on the instrument must be connected to the same phased lead for each speaker.

This instrument will enable the pickup and amplifier to be checked for amplitude and phase balance, whilst the simple aural tests described earlier, will enable the phasing of the speakers to be checked. However, it should be pointed out that there are some stereo records to which phase tests do not apply. These are recordings made with very widely spaced microphones so that no part of the signal heard by one microphone is picked up by the other. These recordings are completely uncorrellated, they produce no centre image, they have two channels, but are not stereophonic. There are also records that shift phase erratically because they have been edited from more than one master stereo recording, but these are not in phase with each other.

It would appear therefore that it is desirable in all stereo equipment to have some facility for changing the phase of one channel. This can simply be done with a double pole change over switch connected to reverse the connections to one pair of speaker leads.

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New Products

ELECTRONICA — GATHERING OF ELECTRONIC SPECIALISTS

Germany's first trade exhibition for electronic components closed with a resolution by the exhibitors, to repeat Electronica in October 1966 in Munich. Electronica 1964 fulfilled and even exceeded the hopes placed into it by its intitators. The majority of those exhibitors who had followed the call to come to Munich found here an interested engineering public not only from the South German area, but also buyers from 33 countries all over the world, among which Switzerland, France, Austria, Great Britain and Ireland were reported to be the most important.

The efforts of the organizers, to maintain the products shown at Electronica, as closely as possible, around the electronic components, has been in the centre of interest, can by and large be rated as successful.

ENQUIRY CARD 115

* * *

NEW SEXLESS MICROWAVE CONNECTOR

Hewlett-Packard in conjunction with Amphenol have developed a sexless microwave connector with outstanding electrical and mechanical properties up to 18 gc.

Improvements in technology and changes in requirements have placed new emphasis on coaxial transmission at frequencies traditionally belonging to rectangular waveguide. Current design leans away from cumbersome waveguide toward cóax with increased flexibility, smaller size, lighter weight, and very broad bandwidth. Microwave semiconductor devices mount in coaxial geometries more easily than in waveguide. Some sections of electronics have already reacted to the new coaxial emphasis; but the microwave technology has been retarded by the lack of suitable connectors.

Connectors in current use were developed at Microwave Research Institute, a division of Polytechnic Institute of Brooklyn, under Navy contract. The type N connector was developed for use on a 3/8" diameter cable. Scaled down version (like the BNC and TNC connectors) also came into common usage. The performance of these connectors, however, is inadequate for today's advancing technology. The shortcomings of these connectors include high and inconsistent reflections, high RF leakage, and inconvenience. Shortcomings arise, among other things, from loose mechanical tolerances, non-coincident mating planes for inner and outer conductor, and the necessity for different male and female connectors to complete a joint.

In the past, measurements on co-axial microwave devices at various calibration laboratories did not agree and a large part of the blame was put on the available connectors. These inconsistent measurements led to the formation of a committee for establishing a group of recommended practices for future connector designs. This committee, now known as IEEE PTGIM Technical Subcommittee on Precision Coaxial Connectors, has divided its "Recommended Practices" into four parts entitled "General Requirements and Definitions", "Parameters to be Specified", "Parameter Limits", and "Test Procedures".

Specification for GPC-7

Upper Frequency Limit, 18 Gc. VSWR, 1.039 max. at 18 Gc. R.F. Leakage (dB below Signal), 130 min. Insertion loss (dB per pair), 0.01 at 3 Gc. Electrical length per pair, 1.85 cm ± 0.005 cm. (Air) O.D. of inner line (Size) I.D. of outer, 0.2756". Type of Mating, Hermaphrodite. Coupling Means, Locking-ramps.

Overall Size: Length, 1.703". Diameter, 0.984.

ENQUIRY CARD 116

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MARCH, 1965

NEW HIGH STABILITY H.F. RECEIVER

A high stability, general purpose, H.F. Receiver, Type H2301, covering the frequency band 500kc/s to 30.5Mc/s is now available from The Marconi Company. This economic and compact receiver is suitable for reception of a.m., c.w. and s.s.b signals, and with the addition of a special f.s.k. adaptor, Type H5011, it can be used with single channel teleprinter circuits.

The frequency range is covered in thirty steps of 1Mc/s with an overlap of 100kc/s and the calibration accuracy is within 1kc/s. The dial calibration is linear and presented in such a manner that the frequency is given by combining the readings on separate 'Mc/s' and 'kc/s' scales. Calibration can be checked at any time with a built-in 100kc/s crystal oscillator.

ENQUIRY CARD 117

* * *

NEW TELEFUNKEN TRANSISTOR TYPES — GERMANIUM PNP AF POWER TRANSISTOR AD 152

This type of transistor closes up the gap in the Telefunken AF line, between the AC 117 and AD 138. Like the AC 117 in the range of power outputs between 05W and 4W, the new transistor AD 152 may be used for general purpose applications in class-B push-pull amplifiers for ratings up to 10W, as well as in class-A circuits for AF output powers between 2W and 3W. Thus the range of application extends from the output stage in car radios, class-A and B amplifiers in radio and TV. sets to high-quality output stages for radiograms and medium-sized power amplifiers.

Germanium PNP Mesa Transistor AF 139

The transistor AF 139 has been designed primarily for incorporation in Band IV and V television tuners for straight amplification as well as in autodyne converter or mixer stages. Measured at 12V and 1.5 VA the noise factor and power amplification are:—

Noise factor at 600Mc/s = 7.5db and Power amplification Vpb = 10 dB.

ENQUIRY CARD 118

NEW AERIAL SYSTEM IS BASED ON SEVENTEENTH - CENTURY INVENTION

A new form of aerial for the radio towers that receive and transmit TV. pictures and telephone calls between cities by very short waves has been developed in Britain. The aerial uses exactly the same principles as a well-known system of optical telescopes invented in the seventeenth century. The aerial is cheaper and smaller in size than other aerials used for the same purpose until now. Radio waves at high frequencies behave like light waves and can be focussed in the same way. Scientists designed the aerial on similar lines to the cassegrain optical system for a telescope. In this system, light rays are collected by a large concave mirror and reflected on to a small convex mirror in front of it. The image is reflected from this through a hole in the centre of the large mirror. The system produces a more precise and sharply focussed image than could be obtained by direct viewing.

ENQUIRY CARD 120

* * *

TIME-DELAY RELAY FROM WESTINGHOUSE

Accuracy and reliability are the chief user benefits of the new time-delay relay (TD-4) available from the Westinghouse Relay-Instrument Division.

The TD-4 relay can be used for any timing application, requiring a two-stage timing interval. One stage is adjustable from 0.1 to 1.0 second; the second stage is adjustable from 0.5 to 3.0 seconds. The relay is operated from a d-c source of 48, 125, or 250 volts.

The time-delay relay is particularly suitable for use as a timing unit for the second and third zone (KD-4 and KD-41) relays in a compensator distance relaying scheme. The new unit provides a single time-delay for zone 2 faults or a longer time delay for zone 3 faults. It can withstand continuous energization up to 110 percent of rated voltage over an ambient temperature range of minus 20 to plus 70 degrees C.

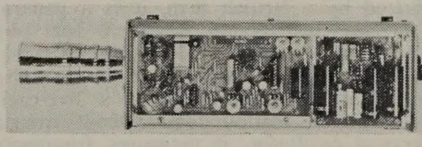
ENQUIRY CARD 121

COMPLETE CLOSED-CIRCUIT TV. STATION BY DU MONT LABORATORIES IS ONE FOOT LONG

A complete closed-circuit television camera system smaller than a shoe box and employing fully transistorized circuitry is announced by Du Mont Laboratories, divisions of Fairchild Camera and Instrument Corp. It is termed the TC-175.

Du Mont Laboratories have produced a complete closed-circuit television camera with its own regulated power supply in one small, light-weight package that is ruggedized against environmental shock, vibration, and temperature extremes.

Horizontal resolution of 700 lines, and



high signal-to-noise ratio help produce sharp, bright pictures at light levels as low as 10 foot candles scene illumination. Useful pictures can be obtained with scene illuminations as low a 1 foot. The camera system may be fed directly to a conventional TV. receiver. An additional output provides for interconnection with any high resolution monitor. Input power required is 117 volts ±10%, 60 CPS, 10 watts.

ENQUIRY CARD 119

LATEST X-RAY EQUIPMENT AT MIDDLEMORE HOSPITAL

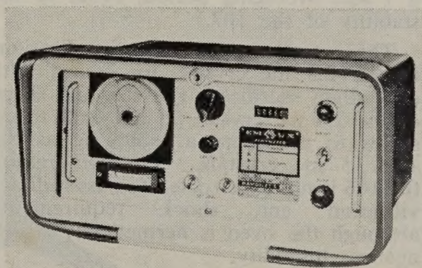
An important piece of equipment recently installed at Middlemore Hospital, Otahuhu, was the Philips Polytome, an apparatus for making radiographs of sections of the body. It was made by the Philips company in Paris and is the only one of its kind in New Zealand. Other units are doing similar work, but not with the same precision.

This equipment is being used for special examinations, when the necessary information cannot be obtained from normal X-ray examination.

The Polytome solves the problem of how to carry out all forms of tomography to perfection with a single piece of equipment.

Tomography, or layer radiography, by the way, is a technique whereby one preselected layer of the body is projected sharply. All unwanted regions above and below it are purposely blurred by movement and leave no sharply projected detail. The minimum layer thickness when the Polytome is used is 1/25th of an inch.

ENQUIRY CARD 122



A NEW 'EMFLUX' AMPLIFIER FROM MAWDSLEY'S

A new, and advanced design of amplifier is now available with the 'EMFLUX' electro-magnetic flowmeter. This instrument, known as the type 3EA gives a complete measuring system within the original compact housing. This feature is incorporated without sacrificing the original facilities for external control and transmission to external instruments.

A new form of direct reading meter, a miniature circular chart recorder and a precision integrator can be fitted together in the type 3EA.

The inclusion of the chart recorder makes the instrument particularly suitable for displaying and recording 'trends' in whatever process is being measured.

ENQUIRY CARD 125

* * *

AERIAL "SIGNPOSTS" FOR RUSSIA

British made beacons have been ordered for the first time by Russian authorities for use when the international radio navigation system of aerial "signposts" is extended to cover the Soviet Union. The system already covers the whole of the Western European air lanes. The order is for two high power long range beacons which are to be installed on the airway between Moscow and the Baltic coast.

ENQUIRY CARD 124

106A AND 106B QUARTZ OSCILLATOR

The 106A/B 2.5 mc Quartz Oscillators broaden the —HP— family of frequency standards, providing fine complimentary instruments to the 107 and 5060 frequency standards.

Before discussing benefits of the 106, it is appropriate to discuss the reason for using a 2.5 mc quartz crystal in the 106, and hence the reason for building a "2.5 mc Quartz Oscillator". The cut resulting in a 2.5 mc frequency of oscillation in quartz approaches the theoretical maximum stability of the quartz; i.e., the cut which disturbs the natural state (or structure) of quartz the least. In sum, it is the cut of the crystal which is mainly responsible for the specified aging rate of 5 parts in 10^{11} per day, an order of magnitude better than the 107 with its 5 mc rock. Placing the crystal in a proportionally controlled double oven — in the 106 the oven is huge — further enhances the stability of the 2.5 mc crystal. In this case, the oven helps to reduce the short term variations to 1.5 parts in 10^{11} for a 1 sec. averaging period, equal to the stability of the 107.

The excellent stability specifications of the 2.5 mc crystal are gained with only slight sacrifice. The size and shape of the 2.5 mc crystal do not lend themselves to as secure a mounting as the 1 or 5 mc crystals. For this reason the 106 is not constructed to pass military vibration and shock requirements, although the oven is hermetically sealed against humidity.

In three areas the 106 excells.

1. The spectral purity of the outputs is excellent. Both harmonic and non-harmonic distortion is as good or better than competitors. In addition, the signal to noise ratio is 87 db; no other manufacturer even specifies it. This excellent level of spectral purity makes the 106's 5 mc output ideal for applications requiring higher frequency.
2. Each output is fully buffered against all types of resistive load changes in the other outputs. This means users can place the 106A or 106B in complex frequency standards systems requiring multiple outputs, with complete confidence the frequency outputs will remain true regardless of accidental (or planned) changes in load conditions.
3. The 106A and 106B both offer phase locking capability, thus providing the user with a means for controlling the output frequency within a limited range by use of an externally applied voltage.

The 106 is ideally suited for use in systems requiring high stability and spectral purity: Microwave Spectroscopy; Doppler Measurements; and similar systems requiring the reference to be multiplied by a large factor. In addition, the 106 may be used as the quartz oscillator reference for the 5100/5110, 5102, and 5103 Sythesizers or as the phase locked oscillator output with the 5060A Cesium Standard.

ENQUIRY CARD 123

New Products

MARCONI SELF-TUNING RECEIVERS

The Marconi Company has a completely new range of radio receivers. Frequencies are selected on simple decad dials, and the receiver then performs all tuning operations entirely automatically, controlled by one man from a central point. This cuts capital and running costs. In the Marconi Self-Tuning (MST) Receiver all units are fully transistorized.

Printed circuit techniques and modular construction are used extensively throughout. To operate an MST receiver the operator simply sets decade dials on a frequency synthesizer unit and presses a button. This initiates the self-tuning action which, within 24 seconds, accurately tunes all stages of the receiver.

ENQUIRY CARD 126

* * *

ELECTRONIC UNIT SIMPLIFIES AIRCRAFT START-UP

A single electronic unit which combines all the functions of starting up an aircraft engine, saving weight and space as well as time, has been developed in Britain. The pilot presses a button to operate the unit and he is then left free to concentrate on other associated take-off tasks. The electronic unit is already being used in Britain's new supersonic TSR-2 strike aircraft, which is now being flight tested. The unit is fed with various signals from the engines as soon as the starter button is pushed. These signals include accurate measurements of engine speed. Logical functions are performed and the resulting outputs operate the engine starting controls in the correct time and sequence.

ENQUIRY CARD 127

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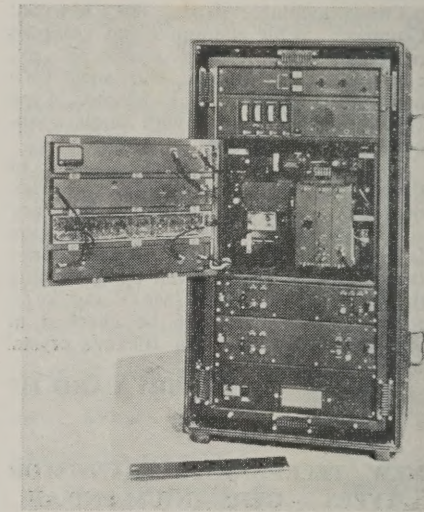
DIGITAL FREQUENCY METER "AMONG CHEAPEST OF TYPE"

A new instrument, which provides a direct digital reading of frequency, period, speed in revs per minute, and number, is claimed to be among the cheapest of its type in the world. Produced by a British firm, it is a general purpose instrument designed for any electronics laboratory doing digital work. The instrument operates on simple pulse counting principles. With a five-digit illuminated readout and 10kc/s quartz crystal oscillator, it measures frequency from d.c. to 10Mc/s, period up to 99999 seconds, and random pulses up to this number provided the separation between successive pulses in greater than 0.1 microsecond. Fully transistorised, it draws only 15 watts from the mains. It measures 20½ins. x 11 x 12 inches deep, weighs 35 lb., and is housed in a metal cabinet suitable for rack or bench mounting.

ENQUIRY CARD 128



THE MH 150 S.H.F. 300-CHANNEL RADIO LINK EQUIPMENT

The Marconi Italiana MH150 is a short-haul, wide-band microwave system designed primarily for military use. It can carry up to 300 telephone channels and is simple, reliable and fully transistorized, except for the transmitting and receiving klystrons. The MH150 operates in the frequency range 7750-8500Mc/s with a nominal power output of 1 watt. It is extremely compact, the complete terminal equipment including power supplies being housed in a single 4ft. rack.

ENQUIRY CARD 131

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PLUG-IN REPLACEMENT FOR MECHANICAL TELEGRAPH RELAYS

A new transistorized high-speed switch, requiring absolutely no 'setting-up' or 'adjustment' throughout its entire life, has been developed by The Marconi Company. This new solid-state switch has been designed to drive electro-mechanical equipment and may be used as a plug-in replacement for the high-speed telegraph relays used in a wide range of telecommunications equipment today.

This robust and reliable switch has many advantages over its mechanical counterpart that requires initial setting-up and regular maintenance. There are no moving contacts and therefore no sparking and corrosion of contact faces. Severe humidity tests have proved that the switch will operate under heavy condensation conditions without any ill effects. Temperature variations from —10°C to +70°C and power supply variations of ±10% also produced no significant effect on the performance.

ENQUIRY CARD 130

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